

**COLOR COUNTRY
GREATER SAGE-GROUSE (*CENTROCERCUS UROPHASIANUS*)
LOCAL CONSERVATION PLAN**

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Color Country Adaptive Resource Management Local Working Group

and

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**Color Country Greater Sage-grouse (*Centrocercus urophasianus*)
Local Conservation Plan**

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I. Executive Summary

The Color Country Greater Sage-grouse Conservation Plan (Plan) is the culmination of nearly three years of effort by the Color Country Adaptive Resource Management Local Working Group (CoCARM). CoCARM members include representatives from state and federal land management and resource agencies, non-governmental organizations, private industry, and private landowners. CoCARM formed in 2003 to proactively manage Greater Sage-grouse (*Centrocercus urophasianus*) populations and their habitats in their local area. These efforts began in response to increasing concern about the status of rangewide sage-grouse populations as well as those within their local area. The impetus for the writing of this Plan came from a mandate by the Utah Division of Wildlife Resources (UDWR) in their Statewide Strategic Management Plan which was passed by the Wildlife Board in 2002.

The Plan will provide an assessment of the status of the Color Country sage-grouse population. The intent of the Plan is to provide guidance and recommendations to meet the overall goal of maintaining and, where possible, increasing sage-grouse populations and improving habitat conditions in the Color Country. The Plan is designed to meet the guidelines set forth by the USFWS in their Policy for Evaluation of Conservation Efforts (PECE) standards. The Plan directly and indirectly addresses the five USFWS listing factors as they apply to Greater Sage-grouse in the Color Country area. Recommendations and guidance suggested within the Plan can be adopted by all CoCARM partners on a voluntary basis. CoCARM encourages participation and adoption of these practices, where applicable, by private landowners in the local area. Participation by private landowners and consideration of needs of the landowner is critical for management of sage-grouse populations and habitat located on private lands and is of great importance in meeting the overall goals of the Plan. True success can only be achieved by managing on an overall landscape scale. The Plan provides an opportunity to promote ecologically sound management of private and public lands for sage-grouse without impinging on private property rights.

Information contained in the Plan is based on a thorough review of the published and unpublished literature relevant to sage-grouse and sagebrush habitats and also on the intimate, local knowledge possessed by CoCARM partners who live and work in the local area. Because a wealth of general information exists about sage-grouse and is available in published documents (Connelly et al. 2000, Connelly et al. 2005), we only provide a brief overview of general sage-grouse ecology and try instead to focus on conditions and issues specific to the Color Country. Knowledge gaps are also identified.

CoCARM analyzed threats currently affecting or have the potential to affect sage-grouse and sagebrush habitats in the Color Country. The Threat Analysis, combined with recommended strategies and actions provides a framework for implementation of the Plan for the next ten years by CoCARM partners. Implementation will be conducted within an adaptive resource management framework. As relevant information from a local and rangewide perspective becomes available, it will be used to modify and refine management strategies, priorities, and general understanding of sage-grouse ecology in the area. Annual evaluation and reporting will be conducted by CoCARM to track progress on the objectives outlined in this Plan.

It is the intent of the CoCARM that this Plan be read and interpreted in its entirety. If the reader reads only isolated sections of this Plan, single statements may be taken out of context or misinterpreted.

II. Introduction

A. Purpose

The mission of the Color Country Adaptive Resource Management Sage-grouse Conservation Plan is to help reach the goal of maintaining and improving current abundances and ensuring the viability of Greater Sage-grouse (*Centrocercus urophasianus*) populations and their habitat in the CoCARM Resource Area, while taking into consideration the historical land uses and long-term socioeconomic issues. The Plan will help to meet this goal by providing local management solutions based on local or compatible data and research to the extent practical. In addition, CoCARM hopes to develop management solutions that will result in diverse and productive sagebrush habitat for sage-grouse while recognizing healthy sagebrush habitats are valuable to the existence of other species. The Plan will identify management areas, key local issues, conservation strategies, population information, research and monitoring needs, and support long-term funding. Adaptive management will be used to maintain the Plan as a continuously evolving document. In addition, the Plan will coordinate development of project proposals in collaboration with the Color Country Utah Partners for Conservation and Development Regional Team to maintain and enhance sage-grouse habitat.

This Plan was called for in, and builds on, the Utah Greater Sage-grouse Strategic Management Plan (Strategic Plan) that was passed by the Utah Wildlife Board in 2002. The Strategic Plan was developed by the Utah Greater Sage-grouse Working Group, which included representatives from state and federal natural resource agencies, and local conservation organizations concerned with the health and proper management of Greater Sage-grouse and sagebrush-steppe ecosystems throughout Utah. The primary purpose of the Strategic Plan was to address declining populations of sage-grouse and to develop a framework for agencies to work within. Further, the Strategic Plan identified certain management units throughout the state where Adaptive Resource Management Local Working Groups could be organized to identify local issues. These groups were then expected to implement local adaptive resource management plans to address declining sage-grouse populations, and the loss, degradation, and fragmentation of sagebrush steppe communities, and the protection and conservation of these and other natural resources into the future.

The Plan is designed to meet the guidelines set forth by the US Fish and Wildlife Service (USFWS) in their Policy for Evaluation of Conservation Efforts (PECE) standards. The USFWS uses PECE standards as a guideline to evaluate whether conservation plans will be considered when making listing and listing priority decisions. The Plan was also written to address the USFWS five Listing Factors:

1. Present or threatened destruction, modification, or curtailment of its habitat or range.
2. Over-utilization for commercial, recreational, scientific, or educational purposes.
3. Disease or predation.
4. Authorities and inadequacy of existing regulatory mechanisms.
5. Other natural or man-made factors affecting its continued existence.

The Plan directly and indirectly addresses the five USFWS listing factors as they apply to Greater Sage-grouse (hereafter referred to as sage-grouse) in the Color Country area. In addition, the Plan will identify issues, potential strategies, and provide for implementation of

proposed conservation actions. The Plan is neither a National Environmental Policy Act (NEPA) decision document, nor a federal or state recovery plan. Any Candidate Conservation Agreement with Assurances developed by the UDWR will be based on the Plan, but will include the NEPA process. Use of this plan by agencies, private enterprise, and private individuals is strictly voluntary. State and federal resource management agencies involved with sage-grouse management, however, are required to manage sage-grouse populations and habitat by various state and federal statutes and policies. The information contained in this Plan is intended to serve as a set of guidelines for those state and federal agencies to maintain and enhance sage-grouse habitat and sage-grouse populations in the Color Country. Participation by private landowners and consideration of the needs of the landowner is critical for management of sage-grouse populations and habitat located on private lands and will be of great importance to meet the overall goals of the Plan. True success will only be achieved by managing on an overall landscape scale. The Plan provides an opportunity to promote ecologically sound management of private and public lands for sage-grouse without impinging on private property rights.

B. Goals and Scope

The goals of the Plan are separated into two categories: Assessment Goals and Strategy Goals. The goals are not listed in any particular order.

Assessment Goals:

The Plan will provide an assessment of the status of the Color Country sage-grouse population by accomplishing the following goals:

1. Estimate current population size and evaluate population trends; estimate amount and condition of habitat.
2. Identify research needs and knowledge gaps.
3. Determine population and habitat needs for the future.
4. Identify and discuss threats that have the potential to impact sage-grouse in the Color Country, especially those associated with the five USFWS Listing Factors.

Strategy Goals:

The intent of the Plan is to maintain and where possible, increase sage-grouse populations and improve habitat conditions in the Color Country by carrying out the following goals:

1. Incorporate management strategies from state and federal agency partners, local governments, and established rangewide conservation and management guidelines (Connelly et al. 2000, Connelly et al. 2004).
2. Increase effective communication with all potential stakeholders in the Color Country and the state of Utah through outreach, information distribution, and education.
3. Address and prioritize threats to aid in prioritizing management solutions.
4. Identify and pursue funding sources, or support partners in their pursuance of funding for projects that will help achieve specific strategies and actions.

Scope

This Plan is designed to span multiple land ownerships and multiple land uses throughout its geographic area. It is our hope that through implementation of this adaptive plan, specific conservation issues will be addressed, implemented, and monitored across geographic and political boundaries, with the intent of increasing the consistency of practices implemented and information collected. The assessment and strategies described herein are specific to the Color Country and were developed with the unique ecological, social, and economic concerns of this area in mind. A detailed description of the Color Country Resource Area is provided later in the Plan.

C. Plan Duration

The Plan was designed and written to be a dynamic, adaptive document that can change with the needs of the local sage-grouse population, their habitat, and the local community as necessary. CoCARM will re-evaluate sage-grouse populations and habitats, and will review progress on strategies listed in the Plan as per the Standard Operating Procedures (SOP; Appendix A). The Plan was written to support conservation actions over a ten-year period. Early termination of the Plan would occur if the sage-grouse was listed under the Endangered Species Act (ESA) or if sage-grouse were removed from the UDWR Sensitive Species list. Species on the Sensitive Species list include those that are federally listed, are candidates for federal listing, or for which there is “credible scientific evidence to substantiate a threat to continued population viability” (Utah Division of Wildlife Resources 2005).

D. Color Country Adaptive Resource Management Local Working Group

As a result of the Strategic Plan, the Color Country Adaptive Resource Management Local Working Group (CoCARM) was formed in 2004 and has worked consistently and cooperatively since then toward the completion and implementation of the Plan. CoCARM was organized and facilitated by Todd A. Black and S. Nicole Frey of Utah’s Community-Based Conservation Program (CBCP), a collaborative partnership between the UDWR and Utah State University Extension Services, with support from the Jack H. Berryman Institute. Dr. Frey and Sarah G. Lupis served as the technical writers of the Plan itself. CoCARM is comprised of state and federal agency personnel, representatives from local government, non-profit organizations, academic institutions, private industry, and private individuals. The agencies, organizations, and individuals who contributed to the Plan through their participation in CoCARM are listed in Table 1. When “we” or “our” is used in the Plan it refers to CoCARM.

The role of CoCARM participants was to guide the development of the Plan and to represent their agencies. After completion of the plan, CoCARM participants will continue to meet to update the Plan, incorporating the results of research and monitoring efforts, new information, and lessons learned through an adaptive management process. Guidance for continued operation of CoCARM can be found in the SOP (Appendix A). The director of the UDWR has the ultimate authority for the Plan.

CoCARM and the CBCP reviewed several local sage-grouse conservation plans, statewide plans, and rangewide plans and assessments from Utah, Colorado, and Nevada to determine the most appropriate structure and content of this Plan. In addition, a thorough literature review was

conducted to ensure that the Plan contained the most recent information available on sage-grouse ecology, life history, and habitat requirements. Annual working group meetings, work plans, and accomplishment reports will monitor progress toward meeting the goals of the Plan. The Plan is intended to be an evolving document. Incorporating principles of adaptive management and keeping the document current as new information arises will help to ensure success of both the Plan and CoCARM.

Table 1. Color Country Adaptive Resource Management (CoCARM) Local Working Group agency, industry, and private partners.

Garfield, Kane, and Piute, County Commissions
Utah Division of Wildlife Resources (UDWR)
USDA Forest Service (USFS)
Utah School and Institutional Trust Lands Administration (SITLA)
Bureau of Land Management (BLM)
USDA/APHIS/Wildlife Services (WS)
National Park Service (NPS)
U.S. Fish and Wildlife Service (USFWS)
Local Soil Conservation Districts (SCD)
Farm Services Agency (FSA)
Utah Association of Conservation Districts (UACD)
Natural Resource Conservation Service (NRCS)
Utah State University Extension (USU/EXT)
GARKANE Power
Natural Resource Extraction Industries
The Nature Conservancy (TNC)
Utah Farm Bureau Federation (UFBF)

Management strategies and recommendations described in the Plan will be updated periodically to incorporate results of research efforts, new information, and the results of management actions through annual reviews and progress reports.

CoCARM operates through an open public process based on consensus decision making. For decisions regarding the Plan, consensus was reached by participating members and/or those present at the time the decision was made. Sections 5 and 6 of the ESA direct state and federal agencies to cooperate in developing conservation activities that protect candidate species. Because the responsibility lies with state and federal agencies, ultimately decisions are limited to them. However, all agencies felt that it was important to involve the public in the decision making and planning process to the greatest extent possible. The importance of public-private partnerships was highlighted in the Statewide Strategic Management Plan (UDWR 2002):

“An important part of solving the habitat management problems that face sage-grouse, is to work together closely so that all landowners and land managers are aware of the needs of local populations and how to meet them.”

CoCARM provided regular opportunities for public involvement, participation, and comment on the Plan. Regular meetings were scheduled to meet the needs of the greatest number of CoCARM participants possible. Meetings were announced via direct mailings and email, on the CBCP web site (www.extension.usu.edu/cbcp), and through personal phone calls and invitations. During the planning process, CoCARM met at least every other month and often every month. Meeting minutes and critical updates were provided via email, direct mailing, and on the CBCP web site. In addition, an annual community forum was held to update the local community on CoCARM's activities and solicit participation and comment from local stakeholders. Annual forums were announced in a similar fashion as regular meetings. The CBCP provided informational material to County Extension offices for display and distribution to the local community and CBCP personnel met regularly with County governments (commissions and councils) to update them on CoCARM's activities and the Plan's progress. The final draft of the Plan was made available to all potential stakeholders that CoCARM was aware of and comments were encouraged.

E. Socioeconomic Considerations Including Consequences of Federal Listing

Communities in the Intermountain West are reflective of diverse and complicated relationships between natural resource extraction industries (agriculture, minerals, energy development, etc.), landownership (private vs. public), and local, state, and federal laws and regulations. These rural communities are also reflective of cyclic (boom/bust) economies and global economics that drive commodity prices. In order to be successful, management recommendations and solutions designed to improve sage-grouse populations and habitats must be reflective and sensitive to local socioeconomic issues.

State and federal agencies will coordinate with local landowners, county, and local governments to develop solutions that will meet ecological requirements while maintaining social and economic values of the local community to the greatest extent possible. Participation by local stakeholders in the planning process has also helped to ensure that recommendations and guidelines presented in the Plan will meet the needs of the local community. In many instances, cooperation between landowners and agencies results in improved feasibility, cost effectiveness, and efficiency of habitat improvement projects that ultimately benefit both sage-grouse and local interests.

Listing the sage-grouse under the provisions of ESA could have a variety of local impacts. Activities that could be affected include noxious weed control, maintenance of rights-of-way, subdivisions and land development, livestock grazing management, big game wildlife management, natural resource extraction, and recreational land use. Broadly applying "take" regulations under the ESA could have a significant local impact. There will likely be an increase in bureaucratic processes in environmental permitting and compliance. Ultimately, the listing could result in slow growth and the elimination of new projects because of the increased cost of environmental permitting and compliance.

In the event of listing, this Plan, along with other local conservation plans, statewide conservation plans, and rangewide conservation assessments and strategies will be used by the USFWS to develop a federal recovery plan. Should these events transpire, the USFWS will also strive to consider to the extent practical, the social and economic needs of the communities within the Resource Area. In the July 1 1994 Federal Register (59 FR 34272), the USFWS

issued a policy to involve stakeholders in the preparation of federal recovery plans to help minimize the social and economic impacts of implementing recovery actions.

F. Management and Legal Authorities

Existing state, federal, and county regulations offer protection to sage-grouse in the Color Country. State laws restrict possession of individual birds. Funding programs in Utah support population and habitat conservation and monitoring activities. Federal agencies, which include the Bureau of Land Management (BLM), U.S. Forest Service (USFS), National Park Service (NPS), Natural Resources Conservation Service (NRCS), and USFWS, have laws, regulations, policies, and funding programs that authorize and support conservation efforts. In the Color Country, some counties have provisions for wildlife or sage-grouse conservation.

Utah Division of Wildlife Resources (UDWR)

Title 23 of the Utah Code is the Wildlife Resources Code of Utah and provides the UDWR with the powers, duties, rights, and responsibilities to protect, propagate, manage, conserve, and distribute wildlife throughout the state. Section 23-13-3 declares that wildlife existing within the state, not held by private ownership and legally acquired, is property of the state. Sections 23-14-18 and 23-14-19 authorize the Utah Wildlife Board to prescribe rules and regulations for the taking and/or possession of protected wildlife.

The UDWR's wildlife management philosophy is captured in its Mission Statement, Strategic Plan, and Comprehensive Wildlife Conservation Strategy (CWCS) approved in 2005 (also known as the Utah Wildlife Action Plan). The mission of the Division of Wildlife Resources is "...to serve the people of Utah as trustee and guardian of the state's wildlife, and to ensure its future and values through management, protection, conservation and education." There are three goals associated with this mission. The resource goal states that the UDWR intends to, "Expand wildlife populations and conserve sensitive species by protecting and improving wildlife habitat." The UDWR 2005-2015 Strategic Plan calls for focusing efforts on increasing the abundance, distribution, and range for species in need of conservation by sustaining and restoring habitat functions. A ten-year, 2005-2015 Comprehensive Wildlife Strategy (a.k.a. Utah Wildlife Action Plan) was approved in 2005 to address species and habitat of greatest conservation need, priorities for conservation, and actions and future implementation opportunities through partnerships.

Sage-grouse are classified as "State Species of Concern" and are among the terrestrial species identified as being in the second tier (i.e., Tier II) of three priority categories of species identified in the CWCS. Approximately 60 species across five taxa in Utah are identified as being potentially petitioned for placement on the ESA defined Threatened and/or Endangered Species list.

Counties

The Board of Commissions for counties in the Resource Area serves as the executive and legislative branches of local government. They have the authority to: 1) protect and promote the health, welfare, and safety of the people; 2) regulate land use, land planning, and quality and protection of natural resources; and 3) has duly adopted regulations and policies to exercise such

authorities including the review and approval or denial of proposed activities and uses of land and natural resources. Currently, Garfield and Kane County Commissioners are rewriting their resource management plan. The following information was excerpted from Garfield County's Draft Resource Management Plan:

- Garfield County desires to have effective coordination, formal participation and cooperation with agencies in planning endeavors as well as site-specific project implementation.
- Garfield County will maintain a Public Lands/Natural Resources Committee, appointed by the County Commission. Public Land/Natural Resources Committee membership will provide information and expertise to the County Commissioners.
- Garfield County desires to have professional, regular, and productive communication with all land management agencies. It is the County's desire to continue with improving the productivity of agency/county communication. Garfield County desires to be provided the opportunity to enter into formal partnerships and agreements with land management agencies on all proposed projects that would affect the County.
- Garfield County desires that traditional resource-based industries and activities return to a more balanced sustained-yield/multiple-use philosophy as described in specific resource chapters. Garfield County desires to partner with land management agencies to maximize opportunities for traditional natural resource based industries as described in resource-specific chapters addressing traditional industries.

Natural Resources Conservation Service (NRCS)

The USDA NRCS has authority to conserve sage-grouse through:

1. Soil Conservation and Domestic Allotment Act of 1936, as amended (P.L. 74-46)
2. Department of Agriculture reorganization Act of 1994 (P.L. 409-354; 7 U.S.C. 6962)
3. The Farm Security and Rural Investment Act (Farm Bill) of 2002 (P.L. 107-171)

The NRCS and Farm Service Agency (FSA) jointly implements programs, which provides landowners with technical and financial assistance to restore and protect grassland, rangeland, pastureland, shrub land and certain other lands, through long-term agreements and easements.

The USDA NRCS offers help to private landowners through the 2002 Farm Bill programs for improving their range and pasture land to the benefit of sage grouse habitat. These practices include watershed practices on private lands such as water developments and fencing for prescribed grazing to improve livestock distribution and vegetative or brush management practices. Improvements to the vegetation can be accomplished with the seeding of introduced and native species of grasses and forbs for forage improvement to benefit both wildlife and domestic animals. Other Farm Bill programs include wildlife enhancement, conservation easements, watershed and riparian programs, and programs to reduce soil erosion.

Bureau of Land Management (BLM)

The United States Department of Interior (USDI) BLM has authority for conservation of sage-

grouse through:

1. Federal Land Management Policy Act (FLMPA) of 1976 (43 U.S.C. 1701 et seq.; 90 stat. 2743; PL 94-579)
2. Sikes Act, Title II (16 U.S.C. 670 et seq.)
3. BLM Manual 6840, Special Status Species Management

Specifically, the FLMPA guidance on sensitive species authorizes that “the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, and environmental, air, and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals...(43 U.S.C. 1701 Sec. 102 (a) (8)).”

The 6840 Manual defines Special Status Species as, “...any species which is listed, or proposed for listing, as threatened or endangered by the U.S. Fish and Wildlife Service or National Marine Fisheries Service under the provisions of the Endangered Species Act; any species designated by the U.S. Fish and Wildlife Service as a ‘listed,’ ‘candidate,’ ‘sensitive,’ or ‘species of concern,’ and any species which is listed by the State in a category implying potential danger of extinction.” The Manual provides for the BLM to implement management plans that conserve these species and their habitats, and to ensure that actions authorized, funded, or carried out by the BLM do not contribute to the need for the species to become listed under provisions of the ESA. In addition, the USFWS Policy: State-Federal Relationships (43CFR part 24.4 (c)) contends that the Secretary of the Interior is responsible for the management of non-wilderness BLM lands for multiple uses, including the conservation of fish and wildlife populations. Finally, the BLM provides conservation guidelines for management of sage-grouse on BLM lands in the National Sage-grouse Habitat Conservation Strategy (BLM 2005).

School and Institutional Trust Lands Administration (SITLA)

In 1994, the Utah School and Institutional Trust Lands Administration was created to manage twelve real estate trusts granted to Utah at statehood (1896) by the United States federal government. SITLA is an independent agency of state government established to manage those lands for the support of common schools and other beneficiary institutions, under the Utah Enabling Act (Title 53C-School and Institutional Trust Lands Management Act).

Title to these trust lands is vested in the state as trustee to be administered for the financial support of the trust beneficiaries. As trustee, SITLA must manage the lands and any revenues generated from the lands in the most prudent and profitable manner possible, and not for any purpose inconsistent with the best interest of the trust beneficiaries. The trust principles impose fiduciary duties upon the state, including a duty of undivided loyalty to, and a strict requirement to administer the trust corpus for the exclusive benefit of, the trust beneficiaries. The beneficiaries do not include other governmental institutions or agencies, the public at large, or the general welfare of the state. SITLA must be concerned with both incomes for the current beneficiaries and the preservation of the trust corpus for future beneficiaries. This requires a balance between short and long-term interests so that long-term benefits are not lost in an effort to maximize short-term gains. SITLA has no jurisdiction over wildlife populations on trust lands. Management of rangelands is addressed in Section 53C-5-101 of the School and Institutional Trust Lands Management Act, which states: 1) The director is responsible for the

efficient management of all range resources on lands under the director's administration, consistent with his fiduciary duties of financial support to the beneficiaries; and 2) This Management shall be based on sound resource management principles.

United States Forest Service (USFS)

The United States Department of Agriculture (USDA) Forest Service has authority for conservation of sage-grouse through the:

1. Multiple-Use Sustained Yield Act (MUSY) of 1960 (P.L. 86-517, 74 Stat. 215, 16 U.S.C. 528, 528-531)
2. Sikes Act of 1960 (P.L. 86-797, 74 Stat. 1052, 16 U.S.C 670 et seq., as amended)
3. Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 (P.L. 93-378, 88 Stat. 476, as amended; 16 U.S.C. 1600, 1600-1614)
4. National Forest Management Act (NFMA) of 1976 (P.L. 94-588, 90 Stat. 2949, 16 U.S.C. 472 et seq.) and its implementing regulations (36 CFR 219)
5. Public rangelands Improvement Act of 1978 (P.L. 95-514, 92 Stat. 1806, 43 U.S.C. 1901-1908)
6. USDA Regulation 9500-4 and the Forest Service Manual (FSM) Chapter 2600

MUSY directs the USFS to administer the National Forest for multiple uses including fish and wildlife purposes, in cooperation with interested State and local governmental agencies and others. "Multiple use" refers to the congruent and coordinated management of the various surface renewable resources so that they are utilized in a manner that will best meet the needs of the American people. The Sikes Act provides authority for cooperative planning, habitat improvement, and providing adequate protection for species considered to be threatened, rare, or endangered by a State agency. RPA and NFMA provide for comprehensive, integrated planning that will provide for the diversity of plant and animal communities to meet overall multiple-use objectives. USDA Regulation 9500-4 directs the USFS to manage "habitats for all existing native and desired nonnative plants, fish and wildlife species in order to maintain at least viable populations of such species." USFS policy includes provisions for the development of conservation strategies for species that could be negatively affected by forest plans or proposed projects (FSM 2621.2).

Memorandum of Understanding (MOU)

There are two Memoranda of Understanding (MOU) that address conservation of sage-grouse. The first was signed in 1999 by members of the Western Association of Fish and Wildlife Agencies (WAFWA) to promote conservation and management of sage-grouse and their habitats. Thirteen states, including Utah, and two Canadian provinces were signatories to that MOU. The second MOU, signed in 2000, is between WAFWA, USFS, BLM, and the USFWS. This MOU provides for cooperation among state, provincial, and federal agencies in the development of a rangewide strategy to direct conservation of sage-grouse and their sagebrush habitats.

An MOU between state and federal agencies within the state of Utah is currently being developed. The MOU promotes the conservation of sage-grouse and their sagebrush habitats, encourages cooperation between signatories, and supports Adaptive Resource Management Local Working Groups as the primary format for addressing sage-grouse and sagebrush steppe

issues in the state.

G. Policy for Evaluation of Conservation (PECE) Standards

The PECE Standards set criteria for the USFWS to use in determining whether a formalized conservation effort contributes to making listing a species unnecessary, or contributes to forming a basis for listing a species as threatened rather than endangered. The draft PECE was published on June 13, 2000 (65 FR 37102), and was finalized on March 28, 2003 (68 FR 15100-115). The PECE contains nine criteria the USFWS will use to evaluate that the conservation effort will be implemented, and six criteria to determine if the action will be effective. Conservation efforts included under this policy include those identified in conservation agreements, conservation plans, management plans, or similar documents developed by federal agencies, state and local governments, tribal governments, businesses, organizations, individuals, and a combination of the above. The criteria are not considered comprehensive. The USFWS will consider all appropriate factors and unique, specific circumstances when evaluating formalized conservation actions.

PECE reviews will be conducted to individual conservation actions (rather than conservation plans). Should Greater Sage-grouse be petitioned for listing or be listed under the ESA, this Plan will be reviewed and assessed as part of the preparation of a listing decision and will follow the most recent procedural guidance. Neither PECE review of this Plan nor signature of this Plan by the USFWS constitutes a PECE review of this Plan.

III. Conservation Assessment

A. General Sage-grouse Biology/Ecology

Numerous authors have described various aspects of sage-grouse biology, ecology, and life history. Several literature reviews have also been published in recent years. For the purposes of this document, we have included the summary from the Statewide Strategic Plan (UDWR 2002) and would recommend the Conservation of Sage-grouse and Sagebrush Habitats by Connelly et al. (2005) for a thorough discussion.

Physical Description

The sage-grouse is the largest grouse species in North America. Adult males are larger than adult females. Adult males weigh 4-7 pounds (1.7-2.9 kg) and are 27-32 inches (65-75 cm) long compared to adult females weighing 2-4 pounds (1.0-1.8 kg) and measuring 20-25 inches (50-60 cm) long. Both sexes have narrow, pointed tails and a variegated pattern of grayish brown, buff, and black on the upper parts of the body, and a diffuse black abdominal pattern. Males have blackish brown throats, a dark V-shaped pattern on the neck, and white breast feathers. When strutting, males inflate two gular sacs of olive green skin and erect hair-like black feathers (filoplumes) on the back of the neck. Females lack the V-shaped pattern, their throats are buff, and their lower throats and breasts are barred with blackish brown (Schroeder et al. 1999).

There are noticeable morphological differences between Greater Sage-Grouse and Gunnison Sage-Grouse. Gunnison Sage-Grouse are two-thirds the size of Greater Sage-Grouse. Gunnison Sage-Grouse tail feathers have horizontal white barring along their length compared to a variegated pattern found in Greater Sage-Grouse. The filoplumes, found only on male sage-grouse, are much thicker and dense in Gunnison Sage-Grouse than in Greater Sage-Grouse. There are also noticeable differences in the strutting behavior of the two sage-grouse species (Young et al. 2000).

Seasonal Movements and Home Range

Sage-grouse populations can be defined as one of two types: 1) non-migratory – grouse do not make long-distance movements between seasonal ranges; and 2) migratory – grouse make long-distance movements between distinct seasonal ranges. Seasonal movements between ranges can exceed 45 miles (75 km; Connelly et al. 1993).

Home-range size for migratory sage-grouse populations can exceed 540 mi² (1,500 km²; Hulet 1983). For non-migratory sage-grouse populations, home range size varies from 4-11 mi² (11 to 31 km²). Sage-grouse exhibit high fidelity to seasonal ranges (Fischer et al. 1993). Females return to the same area to nest each year and may nest near their previous year's nesting site (Bunnell et al. 2000, Gates 1983).

Breeding

The center of breeding activity for sage-grouse is the “lek” or strutting ground. Male sage-grouse begin to congregate on leks in early March and perform a ritualized courtship display. Use of leks may continue as late as early June. Mating occurs on the lek. Fifty to ninety percent

of the males utilize leks during the breeding season. As sage-grouse populations decline, the number of males attending leks may decline or the use of some leks may be discontinued. Conversely, as populations increase, male attendance on leks may increase and/or new leks may be established or old leks reoccupied (Connelly et al. 1981).

Nesting/Reproduction

Nesting generally takes place 1-2 weeks after mating and may continue as late as early June (Wallestad 1975). Sage-grouse generally have lower reproductive rates and higher survival rates than other species of upland game birds (Connelly and Braun 1997). Nesting rates vary from year to year and from area to area (Bergerud 1988, Connelly et al. 1993, Schroeder 1997, Coggins 1998). Connelly et al. (1993) reported that in Idaho up to 45% of yearling and 22% of adult female sage-grouse do not nest each year. Schroeder (1997) found that essentially all female sage-grouse in Washington nested. The variation is most likely a result of the quality of nutrition available and the health of pre-laying females (Barnett and Crawford 1994). Re-nesting by sage-grouse varies regionally from 20% (Hulet 1983, Connelly et al. 1993) to greater than 80% (Schroeder 1997). In summary, sage-grouse have the lowest reproduction rate of any North American game bird and as a result populations are not able to recover from low numbers as quickly as those of other game birds.

Sage-grouse nest success varies from 12 to 86% (Trueblood 1954, Gregg 1991, Schroeder et al. 1999). Adult females may experience higher nest success rates than yearling females (Wallestad and Pyrah 1974). However, differential nest success between age groups has not been observed in other studies (Connelly et al. 1993, Schroeder 1997). Nest success is dependent on vegetation cover type (Gregg 1991). Gregg (1991) reported that the highest nest success occurred in mountain big sagebrush (*A. t. vaseyana*) cover type. Greater cover of medium-height shrubs with grass 7 inches (>18 cm) in height increases sage-grouse nest success (Gregg et al. 1994).

Clutch size of sage-grouse is extremely variable and relatively low compared to other species of game birds (Schroeder 1997). Average clutch size for first nests varies from 6.0 to 9.5 throughout the specie's range (Schroeder 1997, Sveum 1998). These differences may be related to habitat quality and overall health of pre-laying females (Coggins 1998).

Survival Rates

Annual survival rates for yearling and adult female sage-grouse vary from 35 to 85%; adult male survival rates vary from 38 to 54% (Wallestad 1975, Zablan 1993, Connelly et al. 1994). Lower survival rates for males may be related to physiological demands of sexual dimorphism and higher predation rates on males during the breeding season (Swenson et al. 1987).

Sage-grouse predators include raptors, coyotes, ravens, squirrels, and skunks. The increase in urban development has resulted in the addition of non-native predators such as dogs, cats and foxes (Connelly et al. 1991).

Little information has been published on mortality of juvenile sage-grouse or the level of production necessary to maintain a stable population. Among western states, long-term juvenile to hen ratios have varied from 1.40 to 2.96 juveniles per hen in the fall. In recent years, this ratio

has declined to 1.21 to 2.19 juveniles per hen (Connelly and Braun 1997). It is believed that at least 2.25 juveniles per hen should be present in the fall population to allow for stable to increasing sage-grouse populations (Connelly and Braun 1997, Edelman et al. 1998).

B. Habitat Requirements

Breeding/Nesting Habitat

Leks, or strutting grounds, tend to be traditional. In general, the same areas are used year after year. Leks typically occur in open areas surrounded by sagebrush (Patterson 1952, Gill 1965). Examples of lek sites include landing strips, old lakebeds or playas, low sagebrush flats, openings on ridges, roads, cropland, and burned areas (Connelly et al. 1981, Gates 1985). Sage-grouse males appear to form leks opportunistically at sites within or adjacent to potential nesting habitat. The lek is thought to be the center of year-round activity for non-migratory grouse populations (Eng and Schladweiler 1972, Wallestad and Pyrah 1974, Wallestad and Schladweiler 1974), but may not be the case in migratory populations (Connelly et al. 1988, Wakkinen et al. 1992). Average distances between nests and the nearest leks vary from 0.6-3.9 miles (1.1-6.2 km), however, some females may nest > 12.5 miles (20 km) away from the lek (Autenrieth 1981, Wakkinen et al. 1992, Fischer 1994, Hanf et al. 1994).

Habitat used by pre-laying hens is also part of the general breeding habitat. These areas provide hens with forbs high in calcium, phosphorus, and protein, all of which are necessary for egg production. The condition and availability of these areas are thought to have a significant effect on reproductive success (Barnett and Crawford 1994, Coggins 1998).

Most sage-grouse nests are located under sagebrush plants (Patterson 1952, Gill 1965, Gray 1967, Wallestad and Pyrah 1974), however, nests have been found under other plant species (Griner 1939, Connelly et al. 1991, Gregg 1991). Those sage-grouse nesting under sagebrush experience a higher nest success than those nesting under other plant species (Connelly et al. 1991). Research on sage-grouse nesting habitat has documented that sage-grouse tend to select sites under sagebrush plants that have large canopies. The canopies provide overhead cover and an herbaceous understory, thus providing lateral cover and allowing birds to hide from view (Patterson 1952, Gray 1967, Klebenow 1969, Wallestad and Pyrah 1974, Wakkinen 1990, Gregg 1991, Fischer 1994, DeLong et al. 1995, Bunnell et al. 2000). Herbaceous cover associated with nest sites may provide scent, visual, and physical barriers to potential predators (DeLong et al. 1995).

Brood-rearing Habitat

Early brood-rearing habitat generally occurs relatively close to nest sites, but movements of individual broods may be highly variable (Connelly 1982, Gates 1983). Early brood-rearing habitats may be relatively open stands of sagebrush when compared to optimum nesting habitat (Martin 1970, Wallestad 1971), but need > 15% canopy cover of forbs and grasses (Sveum et al. 1998, Bunnell et al. 2000). High plant species richness with abundant forbs and insects characterize brood areas (Dunn and Braun 1986, Klott and Lindzey 1989, Drut et al. 1994, Apa 1998). Insects, especially ants and beetles, are an important food component of early brood-rearing habitat (Drut et al. 1994, Fischer 1996). As herbaceous plants mature and dry, hens usually move their broods in June and July to mesic sites where more succulent vegetation is available (Gill 1965, Klebenow 1969, Connelly and Markham 1983, Connelly et al. 1988, Fischer 1996, Bunnell et al. 2000). Sage-grouse broods occupy a variety of habitats during summer including sagebrush, relatively small burned areas within sagebrush, wet meadows,

farmland, and other irrigated areas adjacent to sagebrush habitats (Savage 1969, Martin 1970, Connelly and Markham 1983, Gates 1983, Connelly et al. 1988, Pyle and Crawford 1996).

Late brood-rearing habitats are highly variable. Patterson (1952) reported that grouse move from summer to winter range in October but during mild weather in late fall some birds may still use summer range. Fall movements to winter range are slow and meandering and occur from late August to December (Connelly et al. 1988). Wallestad (1975) documented a shift in feeding habits from September, when grouse were consuming a large amount of forbs, to December when birds were feeding only on sagebrush.

Winter Habitat

Sage-grouse winter habitats are relatively similar throughout most of their range. Because their winter diet consists almost exclusively of sagebrush, winter habitats must provide adequate sagebrush that remains accessible through the winter. Eng and Schladweiler (1972) and Wallestad (1975) indicated that in Montana most observations of wintering sage-grouse occurred in sagebrush habitats with > 20% canopy cover. However, Robertson (1991) indicated that sage-grouse used sagebrush habitats that had average canopy cover of 15%. Sage-grouse tend to select areas with both high canopy cover and taller individuals of big sagebrush (*Artemisia tridentata*).

During winter, sage-grouse feed almost exclusively on leaves of sagebrush (Patterson 1952, Wallestad 1975). Big sagebrush dominates the diet of sage-grouse in most portions of their range (Patterson 1952, Wallestad 1975, Remington and Braun 1985, Welch et al. 1988), but low sagebrush (*A. arbuscula*), black sagebrush (*A. nova*) (Dalke et al. 1963, Beck 1977), fringed sagebrush (*A. frigida*; Wallestad 1975), and silver sagebrush (*A. cana*; Aldridge 1998) are also consumed in many areas depending on availability. Sage-grouse in some areas apparently have a preference for Wyoming big sagebrush (*A. t. wyomingensis*; Remington and Braun 1985, Meyers 1992) and in other areas, mountain big sagebrush (*A. t. vaseyana*; Welch et al. 1988). Some of the differences in selection may be due to preferences for higher levels of protein (Remington and Braun 1985).

It is critical that sagebrush be exposed at least 10-12 inches (25 cm) above snow level (Hupp and Braun 1989). This provides both food and cover for wintering sage-grouse. In situations where snow covers the sagebrush, birds will move to areas where sagebrush is exposed. During winter, sage-grouse will either partially or completely bury themselves in snow (snow roosting) for added thermal protection from winter temperatures.

C. Distribution and Abundance

Populations of Greater Sage-grouse have been declining for the past 25 years (Braun 1995, Connelly and Braun 1997, Beck et al. 2003, Connelly et al. 2004). Concerns about population status and distribution have heightened awareness about the appropriateness of various monitoring efforts and techniques. Connelly et al. (2000) indicated that monitoring was a key component of sage-grouse management. Utah's Strategic Management Plan (UDWR 2002) also emphasizes the need to monitor sage-grouse populations and habitats. Further, the MOU signed by WAFWA representatives in 1999 and with federal agencies (2000) call for consistent monitoring and data collection.

Utah and the Color Country historically have used several techniques to assess sage-grouse population trends, status, and distribution including lek counts, brood surveys, field bag checks, wing barrels, and hunter surveys. Currently, the primary technique employed by biologists in Utah and in the Color Country is lek counts. This method is described in detail later in this section.

Historic Distribution of Sage-grouse

Determining historic distribution of sage-grouse is difficult and problematic for several reasons, but primarily because scientific studies are not available historically. For many areas, no written or zoological records exist. It is believed that sage-grouse once existed in all 29 Utah counties. Today sage-grouse are found in 26 counties in Utah and are thought to occupy 50% of the habitat they once did (UDWR 2002).

The Rangewide Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats (hereafter referred to as the Rangewide Assessment; Connelly et al. 2004) analyzed the historic distribution of sage-grouse based on historical sage-grouse distribution maps, habitat maps, sage-grouse museum specimens, known lek locations, and research on sage-grouse movement patterns and habitat use. The authors define historic distribution as a "pre-settlement" distribution, occurring prior to 1800 when rapid settlement by people of European descent began.

The Rangewide Plan describes potential historic distribution of sage-grouse in the Color Country as part of the evaluation of historic range in the Wyoming Basin (Connelly et al. 2004). The authors state that there are no records of sage-grouse observations in the eastern portion of the Wyoming Basin in what is now the Color Country, but are unable to account for this discrepancy with current observations of the species in this area. Further, they indicate that the distribution of forested habitats would have prevented sage-grouse from occupying portions of the Uinta Mountains in Utah.

Lek Counts

During the breeding season, sage-grouse congregate on a relatively small number of sites, called leks, to display and breed. Because sage-grouse demonstrate high fidelity to lek sites, they offer the best opportunity for monitoring populations (Jenni and Hartzler 1978, Beck and Braun 1980, Connelly et al. 2000, 2003, 2004). Lek count methodology was first described by Patterson (1952) who studied sage-grouse in Wyoming. His methodology was based on a count of the

maximum number of males observed on a lek over a series of 3-4 visits. The method described by Patterson (1952) results in an index of the population. Population indices, commonly used by wildlife managers, involve a count or measurement of some aspect of the population that is both convenient to measure and thought to be related to abundance (e.g., birdcalls, pellet counts, roadside observations, and track surveys). The shortcomings of this type of sampling were described by Anderson (2001) whose primary criticism was that population indices fail to lead to a defensible estimate of population size or status. Specifically in regard to lek counts, Beck and Braun (1980) noted that conclusions about population size and status are only gleaned when the following information is known: total number of leks in an area, attendance patterns of adult and yearling males, inter-lek movements patterns, and the ratio of males to females (i.e., the relationship between the maximum count and the size of the population).

Despite the problems associated with indices and lek counts, they remain the best available and primary means for assessing population trends and estimating population size and status (Autenrieth et al. 1982, Connelly et al. 2000). Throughout Utah, lek counts are conducted between late February and May (depending on weather conditions and access to lek sites) on all known leks to the extent possible. Leks are counted 3-4 times during this period and counts are made between 30 minutes before and 1 hour after sunrise. An estimate of population size is calculated based on the following assumptions: 1) 75 % of all males were counted on strutting grounds and 2) that the male:female ratio in the population is 1:2 (UDWR 2002).

The number of active leks in an area can also be used as an indicator of population size. Cannon and Knoph (1981) noted that lek numbers seem to increase roughly in proportion to population size. There is evidence that as population size increases, attendance at established, “traditional” leks increases, while smaller “satellite” leks appear and then disappear as population size decreases. In Utah, a lek is defined as a site or area traditionally used for display. Leks are considered “active” when at least two males have been observed for at least three years. Conversely, leks are considered “inactive” when birds have been absent from a traditional site for more than three years. Using the number of “active” or “traditional” leks as an indicator of population size is also problematic. Satellite leks are typically smaller and are likely to be less noticeable, lek detection is likely to vary with both density of leks and population density, and search effort likely plays a large role in detection and consistency of measurement.

D. Assessment of Local Population

Plan Area

The Color Country Resource Area (Resource Area) is located in south-central Utah in Piute, Garfield, Sevier, and Kane counties. The Resource Area encompasses 4,956,258.7 acres. The majority of the Resource Area is managed by the USFS, BLM, the state of Utah, and private landowners (Table 2). The Resource Area is defined by regional land features and habitat to the north and northeast, the Colorado River to the east, the Arizona to the south, and regional land features to the west. The Resource Area has been subdivided into three subunits, corresponding to sage-grouse breeding complexes (Figure 1). These breeding complexes are based on geographic boundaries and groupings of leks. Although movement between complexes is likely, the complexes represent discrete subpopulations of sage-grouse in the Resource Area.

Precipitation ranges from 5-10 inches across the Resource Area, most of it falling during the winter months. Temperatures also vary greatly across the region. Piute County, in the northern portion of the Resource Area, has an average temperature in July of 85°F, while in Garfield County, to the south, the average temperature in July is 66°F.

Landownership

Much of the Resource Area is managed by the federal government. For example, in Garfield County 43% of the land is managed by the Bureau of Land Management and 31% by the Forest Service, with only 4% of the county's land owned by private residents. In Kane County, over 80% of the land is federally owned while approximately 10% is privately owned. Much of the eastern portion of the Resource Area includes National parks and monuments, and has little sage-grouse habitat.

Table 2. Landownership and management jurisdiction by acre and percentages within the CoCARM Resource Area.

Land Type	Area (acres)	% of Resource Area
Bureau of Land Management	2,410,369	50
BLM Wilderness	21410.3	< 1
National Recreation Areas	514719.2	11
Native American Tribes	543.99	< 1
National Park Service	76,124	2
Private	406,477.9	8
State of Utah	185,941	4
US Forest Service	1,160,209	24
Water	75836	2

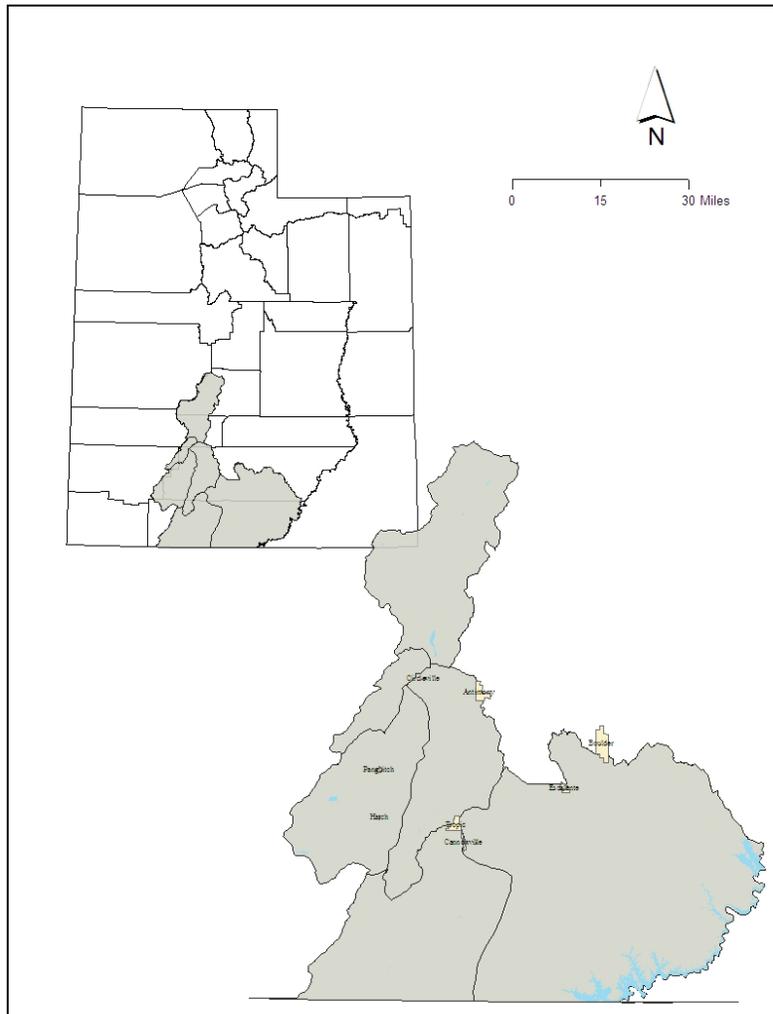


Figure 1. General location of the CoCARM Resource Area with sub-units displayed.

Wildlife Populations

Several species of birds, small mammals, and reptiles reside only in sagebrush environments. Passerine birds obligated to use sagebrush environments include Brewer's sparrow, sage sparrow, and sage thrasher. Additionally, vesper sparrow and loggerhead shrike are also commonly found in sagebrush communities in the Resource Area, although not obligated to it. Other obligate species include the sagebrush vole and the sagebrush lizard. In addition to these obligates, a large number of other birds, small mammals, and reptiles commonly make use of sagebrush environments within the Resource Area.

While sage-grouse populations in the Resource Area have been counted and studied, little or nothing is known about the local status of these other wildlife species listed above. It is assumed that their numbers and geographic extent are tied to the condition and extent of big sagebrush communities. This plan operates with the intent that maintenance of substantial areas of high quality sagebrush steppe, measured by healthy populations of sage-grouse will provide sufficient habitat for these other sagebrush obligate species to thrive in the Resource Area.

Human Populations

From 800–1200 AD, Fremont Indians were the first humans to practice agriculture in the area. In the 1500s, Spanish conquistadors explored the area. Settlers from the Mormon church, arriving in the 1850s, were the first Europeans to inhabit the area. Human populations have changed little in Garfield and Kane counties over the last century. The cattle and dairy industries used the Resource Area heavily in the 1870s after the construction of railroads in this region.

Today, ranching is still a common way of life for residents within the Resource Area, with roughly 20% of the economy based in agricultural practices. The economies of Garfield and Kane counties rely heavily on the tourism industry.

Kane County and Garfield County contain 54 and 22 % of Utah's coal resources respectively. This includes the Smokey Mountain coalfield currently contained within the Grand Staircase Escalante National Monument. Although there is one request for coal leasing in the Alton coalfield, there are currently no authorized coal leases in the Kanab BLM Field Office. In the past, there were 31 coal leases. Coal production in Kane County was about 70,000 short tons through 1971. No coal production has occurred in either county since 1971 (Utah Energy Office 2004). Current land use planning documents, however, mandate providing sufficient coal to meet regional and national demands consistent with departmental policy. With probable increases in demand, it is expected there will be leases in the future.

Livestock Grazing

The history and place of herbivory in the Intermountain West often leads to debate about the appropriateness of domestic livestock grazing on federal lands (Vavra, et al. 1994, Clifford 2002). Young (1994), Young et al. (1976), Vale (1975), and Daubermine (1970) have all indicated our current plant communities are different from those present "pre European contact." All have listed numerous reasons for this difference including grazing, fire, nonnative

introductions, agriculture, and more recently climatic change. In response to this assumption, land management practices (livestock grazing) were often developed with an additional assumption that livestock grazing was an unnatural impact on native plant communities. From a somewhat different slant, Burkhardt (1996) questioned the often-held assumption that Intermountain plant communities evolved without the presence of large herbivores (i.e. bison, elk). Burkhardt believes that plant communities in the Intermountain West did evolve in the presence of grazing by large herbivores and paleontological and geological records indicate Pleistocene era plant communities were similar to the present native flora of the Intermountain West.

Livestock grazing was introduced into the Intermountain West in the mid to late 1800s. Records indicate livestock grazing was introduced to the Resource Area in the 1850s (Athearn 1982). Grazing was unregulated in the Resource Area until the formation of the USFS in 1903 and the formation of the Grazing Service in the 1930s. Historical numbers of livestock in the Resource Area have varied and, like other areas in the west, were affected by weather, markets, regulation, and other similar factors. There has been a general decline in sheep numbers in the Resource Area over the last 50 to 60 years while cattle numbers increased into the 1960s and then began to decline. Today, however, cattle and calves remain the top agricultural commodity produced in the Resource Area.

Farming

Small homesteads, generally located near water sources and wet meadows, were scattered across much of what is now the study area. These homesteads may have protected water sources from extensive livestock grazing. Many of these homesteads maintained small alfalfa fields, which provided sage-grouse brood habitat. Most of these homesteads, and their associated hayfields were abandoned by the end of the 1950s.

Sage-grouse Population Status and Distribution

Sage-grouse populations in the Color County area have been variable in recent history. In the study area, a review of three lek clusters (Figure 2) defined by the region of their location, illuminates the fluctuations evident in sage-grouse populations. However, it is clear that two of the three illustrated lek clusters have experienced an obvious downward trend over the last 20 years. Alton Sink Valley has historically never had a large number of males in attendance. With steadily lower numbers, there is concern that this lek could blink out of existence if current trends persist. All three lek groups experienced a decline in attendance in 2002 and 2003 presumably due to extreme drought conditions in the region.

Many of the leks are located in Panguitch Valley in the center of the Resource Aea. Their distribution in the Resource Area is limited by natural habitat conditions that are unsuitable for sage-grouse.

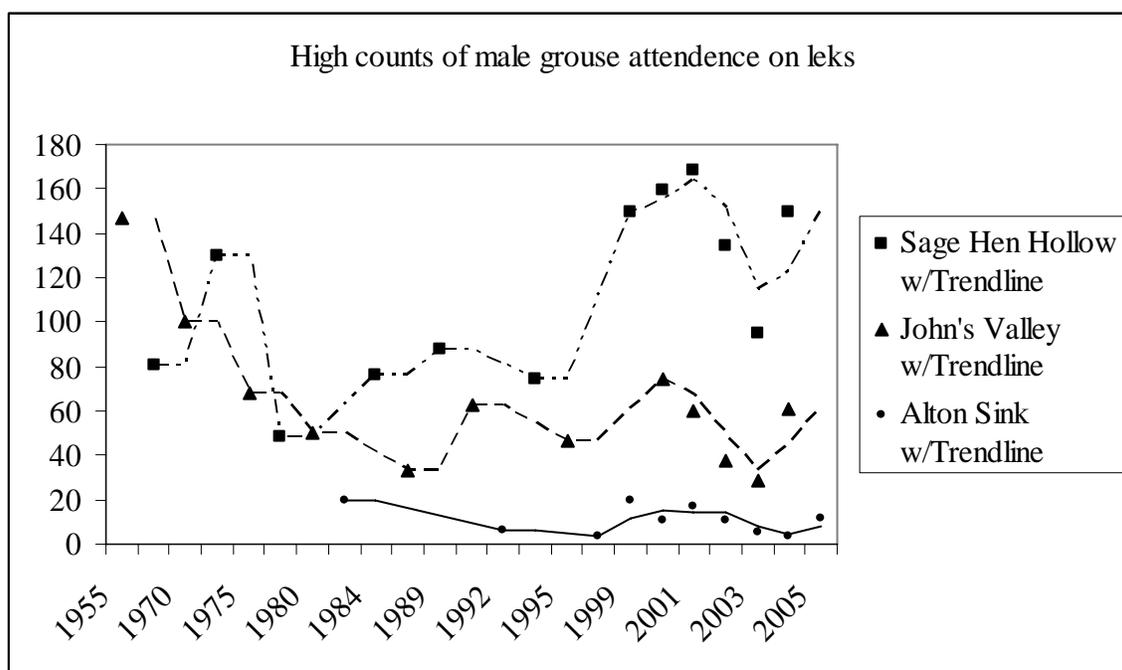


Figure 2. Male grouse attendance counts at each lek cluster in the Color Country working group area, 1955-2005. The trend line represents a 5-year moving average.

Local Ecology and Life History

Little published information is available regarding the ecology and life history of sage-grouse populations in the Resource Area. Although monitoring (lek counts) has been conducted regularly since the late 1960s, few studies have documented information about aspects of habitat use, survival, sources of mortality, and reproductive success.

In February 2005, a radio-telemetry study was started in Alton, Utah to determine basic natural history questions of sage-grouse in the Sink Valley, as well as determine how many birds used this area and at what times of the year. This data will increase our knowledge of sage-grouse ecology in the Resource Area.

Research on radio-collared sage-grouse can provide a wealth of information about varied aspects of local sage-grouse ecology, population status, and movements. However, there is a need for greater standardization of methods and greater quantification of information. Specifically, we recommend that future research projects follow guidelines developed and summarized in Connelly et al. (2003), especially regarding the collection of habitat data. Although the studies conducted to date have yielded beneficial information, data collection could have been more rigorous and, ultimately, more useful with little additional effort. Further, as part of an adaptive management strategy, results should regularly be shared with partners of the CoCARM local working group to inform decisions and guide management and planning. Finally, as this summary indicates, research has focused on birds in the Sink Valley area. We recommend that future research strive to address areas and subunits of the Resource Area for which little information is known.

Local Habitat

In 1999, the UDWR mapped the extent of seasonal habitat types in the Resource Area was mapped. Figures 3 and 4 illustrate where nesting, brood-rearing, and winter habitats are located in the Resource Area.

Habitat Improvements and Completed Conservation Actions

Over the past several years, the BLM and UDWR participated in several projects to improve degraded areas in an effort to improve sagebrush habitat. Future endeavors will continue to improve sagebrush-steppe habitat conditions, including reducing encroachment by pinyon and juniper trees, improving sagebrush age-class distribution, and improving landscape connectivity. Table 3 lists the acreage and general location of habitat improvement projects implemented in 2004 and 2005 and proposed for 2006 by land management agencies of the Resource Area.

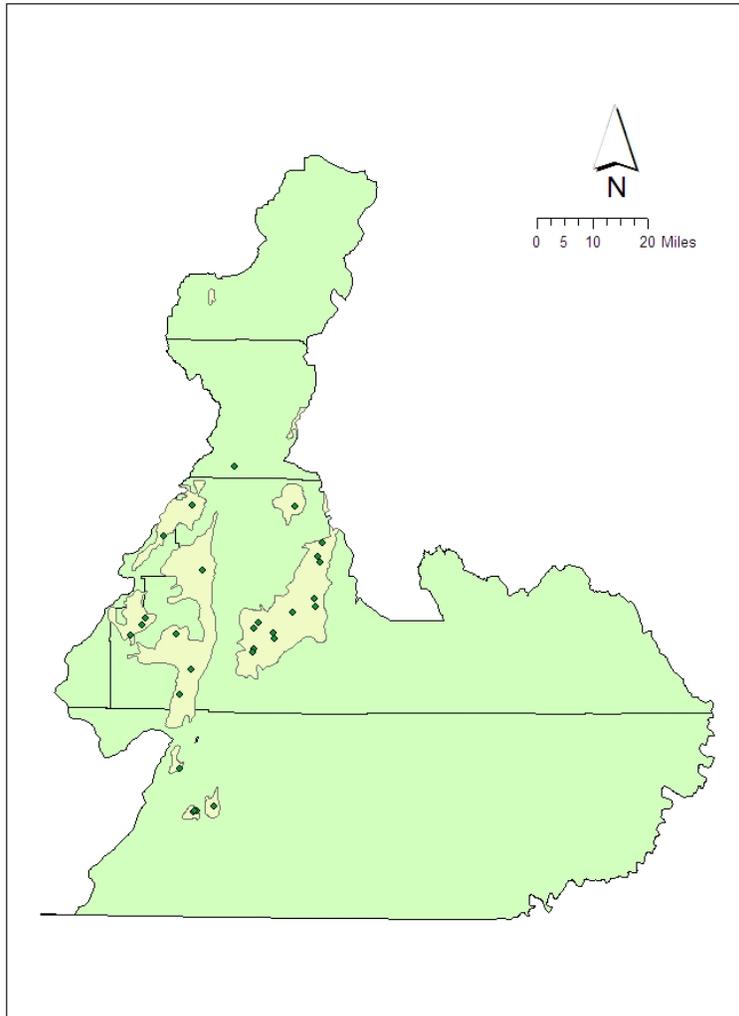


Figure 3. Location of sage-grouse nesting and brood-rearing habitat in the CoCARM Resource Area as identified by the UDWR, 1999. Points represent lek locations.

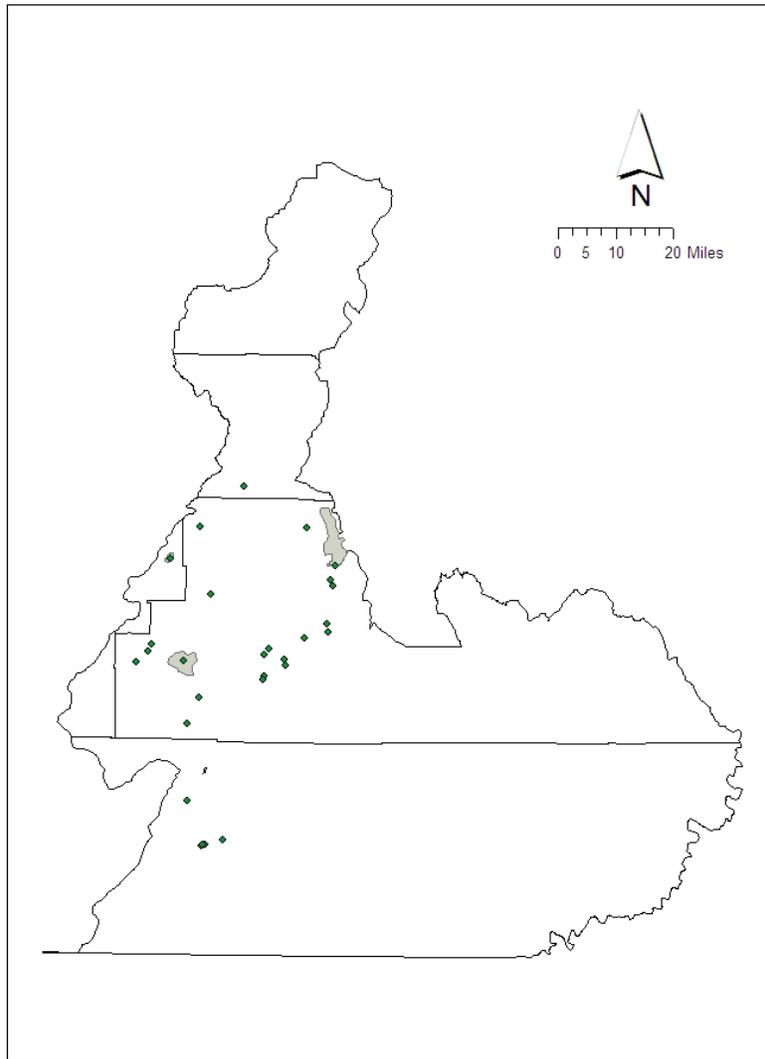


Figure 4. Location of sage-grouse winter habitat in the CoCARM Resource Area as identified by the UDWR, 1999. Points represent lek locations.

Table 3. Habitat improvement projects implemented in 2004 and 2005 and proposed for 2006 by the UDWR, SITLA, USFS, and BLM.

Year	Project Name	Acres
2004	Spencer Ranch – Dixie Harrow/Reseeding	200
	Carrol Ranch – Burn/Chain/Reseed	300
	Brinkerhoff Ranch (SITLA) – Brush/PJ clearing and reseed	640
2005	Heaton Ranch – Water Development	5
	Sorensen Ranch – Water improvement/Livestock grazing management/PJ treatment	150
	5-mile Hollow Sagebrush Restoration	1700
	Alton Sagebrush Restoration	1700
	Carrol Ranch – Brush/PJ treatment/Reseeding	550
2006	Sorensen Ranch – Brush treatment/Reseeding	300
	Spencer Ranch – PJ/Oak/Brush treatment/Reseeding	400
	Seven Mile North – Dixie Harrow	6000
	Boulder Mtn. Rehabilitation	995
	Sevier Plateau Dixie Harrow	500

IV. Threat Analysis

In this section, we summarize and describe the potential threats to sage-grouse populations in the Resource Area. Where possible, we describe actual, known impacts to sage-grouse and their habitats, however, due to a lack of empirical information regarding many of the threats described, we are only able to present general information and make educated extrapolations to the local area. Potential threats are listed in alphabetical order below.

A. Development and Human Infrastructure

In this section, we summarize the potential effects of development and human infrastructure including:

1. Homes and cabins
2. Power lines, fences, and other tall structures
3. Renewable and non-renewable energy
4. Roads on sage-grouse populations in the Resource Area

These impacts were considered together because they are associated with similar stresses (loss of habitat quality and quantity, habitat fragmentation, direct disturbance, and increased predator pressure). There is little empirical evidence available regarding the direct or indirect impacts of most of the threats reviewed in this section, especially that specific to the Resource Area.

Home and Cabin Development

Home and cabin development impacts sage-grouse populations through direct loss of habitat, habitat fragmentation, increases in domestic predators (i.e. dogs and cats), and can lead to increases in other threats including power lines, fencing, roads, and incompatible OHV recreation.

Currently the human population within Color Country is not increasing at a pace that causes concern to the working group. Panguitch in Garfield County, and Kanab in Kane County, are the only sizable towns within the Resource Area. Development in Panguitch does not appear to be increasing. In fact, the census for Garfield County was lower in 2004 than in 2000. However, in the last three years, land has been selling at an inflated price, indicating future housing development in the area. It is projected that there will be 400 new lots developed in Alton, Utah over the next several years. Additionally, a 300-acre subdivision has been planned for Panguitch. In this area, the subdivision of farmland and the corresponding roads and infrastructure may raise concerns in the future. In Kanab, the population is increasing. In this area, subdivisions of farmland into small ranches and communities have become a recent trend. Yet, sage-grouse habitat currently does not exist in this area. Our concern toward Kanab is the increase in outdoor recreation within the Resource Area that may occur as this town grows.

Power lines, Fences, and Other Tall Structures

Although this threat is poorly understood, sage-grouse are potentially vulnerable to increased mortality and disturbance resulting from man-made structures including fences, power lines, and other tall structures such as wind turbines and communication towers. Sage-grouse may fly into

power lines, fences, and other tall structures which can result in death or may injure them to the point where they can not effectively avoid predators. Sage-grouse mortalities due to collision with power lines, fences, and other tall structures have been observed in Colorado, Utah, and other areas (Gunnison Sage-grouse Rangewide Steering Committee 2005). Construction of any structure can result in some habitat loss and fragmentation. Fragmentation may increase vulnerability to predation.

In areas where farms have been subdivided or developed, fences have increased in number over the years. As rural properties are developed, new county roads are constructed. Currently, this is not a concern for the Resource Area. However, as the human population increases, the working group will be proactive in discussing new developments to preclude any conflicts.

Renewable and Non-renewable Energy Development

Under the current Federal Administration, oil and gas exploration and development potential has increased in the Resource Area. In Alton/Sink Valley, an area has been leased for coal mining. The activity and development associated with this mine could have detrimental effects on sage-grouse brood-rearing habitat. However, positive effects such as habitat restoration as a mitigation practice are also possible. While exploration has yet to occur, other sections of the Resource Area are also open for leasing.

Presently, oil and gas mining occurs in one valley comprising two wells, in Garfield (Upper Valley; Figure 5). It is unknown what the future activity may entail. Oil and gas facilities generally have a small footprint, usually a few acres or less. Each pad will often contain tanks and other equipment for a period of years. When the well is depleted, all facilities are removed and the pad is completely reclaimed. Some researchers believe these facilities suppress sage-grouse use of habitat for some distance beyond the actual footprint of the facility (Robel et al. 2004). Compressor stations, active wells, and drilling rigs produce relatively loud and sustained noise that can purportedly interfere with sage-grouse, particularly during the breeding season.

Effective reclamation of oil and gas pads and other facilities, including the re-establishment of big sagebrush in some instances, is important for maintenance of sage-grouse habitat in these development areas. This can be challenging in drier portions of the Resource Area. Reclaimed pad sites have been used as leks sites in some areas (B. Maxfield, UDWR, personal communication).

Roads

Collisions with motor vehicles, while either flying or walking on or across roadways, are also potential causes of direct mortality or severe injury for sage-grouse. Road construction can cause an increase in dust on plants, spread of invasive/alien species, and increased access for predators and incompatible recreation activities (Gunnison Sage-grouse Rangewide Steering Committee 2005). New and expanded highways, roads, and rail sidings have been built to service energy development, ranches, and residential properties throughout the Resource Area.

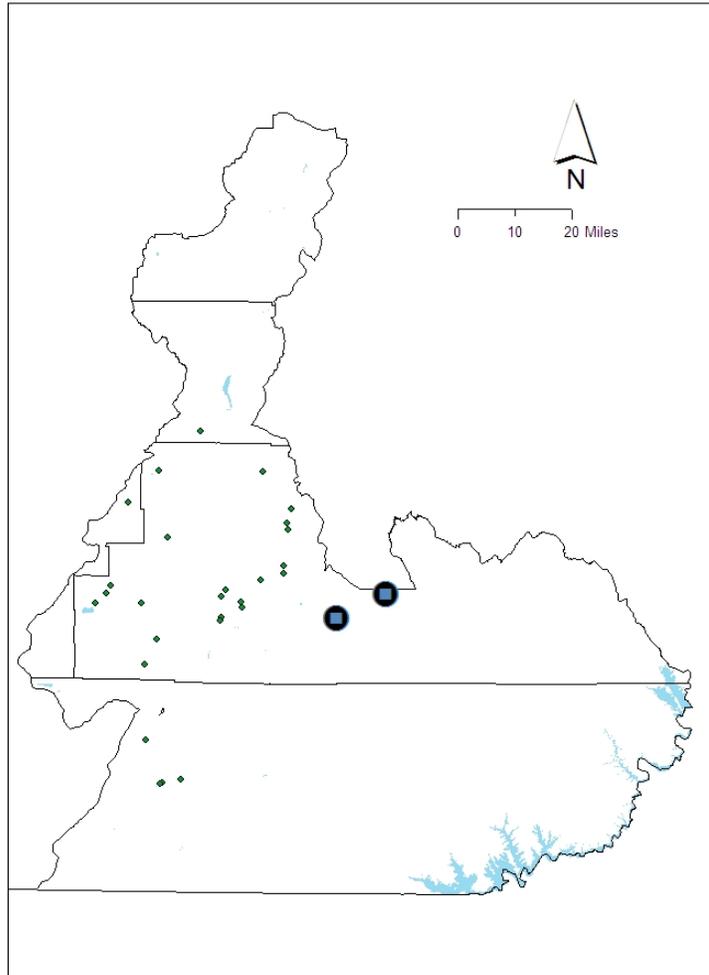


Figure 5. Location of drill sites in the CoCARM Resource Area. Data obtained from http://www.ogm.utah.gov/oilgas/MAP_SEARCH/map_search.htm

B. Drought and Weather

Long periods of below average precipitation, above average summer temperatures, above average snowfall, or below average winter temperatures can have adverse effects on sage-grouse reproductive success and survival. In fact, prolonged drought during the 1930s and in the latter part of the 20th century coincided with declines with sage-grouse populations throughout their range (Patterson 1952, Fischer 1994, Hanf et al. 1994). Extreme climatic conditions have the potential to adversely affect food quality and/or abundance and hiding cover (Hanf et al. 1994, Fischer 1996).

Sage-grouse can be very sensitive to fluctuations in annual moisture (Patterson 1952, Fischer 1994, Hanf et al. 1994). Sage-grouse summer diet, especially for chicks, is heavily dependent on insects and succulent plant growth. Sage-grouse population declines in some areas have been linked to years of low precipitation, most likely due to low nest success and/or poor chick survival (Hanf et al. 1994; Fischer 1996).

The Resource Area experienced drought conditions from 2000–2004 and is currently considered to be emerging from drought conditions. Drought can cause sagebrush die-off as well as limit the availability of brood-rearing habitat in intermittently riparian areas. In areas where die-off due to drought has occurred, the Utah Division of Wildlife and cooperating federal agencies are addressing this die-off with their habitat restoration initiative.

Severe winter conditions can be a factor in reducing grouse survival but there is no conclusive evidence to support this claim (Wallestad 1975; Beck 1977; Robertson 1991). Winter snow accumulations force birds to move to areas blown free of snow or areas in which sagebrush extends above the snow (Eng and Schladweiler 1972; Wallestad 1975; Beck 1977; Hupp and Braun 1987; Robertson 1991).

The impact of severe winters on sage-grouse populations in the Resource Area is not well documented by research. However, local residents were interviewed by UDWR and USU Extension regarding historical populations of sage-grouse. M. Dodds remarked:

“My recollections as I look back, (there were) 1,000s of sage grouse in the summer. You didn’t need a shotgun to shoot them. But every time we went up Little Valleys we’d come back with a few Sage hens for breakfast the next morning. In 1949 we had a terrible winter (and) in the spring there were sage-grouse dead everywhere. That was my first recollection of the sage grouse declining and they didn’t come back fast.”

The winter of 1983–84 was particularly severe, bringing extreme cold and heavy snow to Utah (and many parts of the western United States) for an extended period. It is believed that sage-grouse populations declined dramatically during this winter as well.

Poor weather conditions in the spring are also suspected of influencing sage-grouse production (Connelly et al. 2000). Good winters followed by relatively wet springs can increase production (Wallestad 1975, Autenrieth 1981) by promoting insect and forb production. In contrast, severe spring weather (cold temperature combined with rain and wind) that coincides with hatching can decrease production (Wallestad 1975).

C. Hunting Pressure

Connelly et al. (2000) maintain that most sage-grouse populations can sustain controlled hunting seasons, but caution that sage-grouse have the lowest reproductive potential of the upland game birds, that small populations (< 100 male sage-grouse counted during spring lek counts) are highly vulnerable, and that harvest rates should not exceed 10% of the fall population. Connelly et al. (2003) found that non-hunted populations recovered faster than populations receiving light to moderate hunting pressure. They recommend that sage-grouse hunting seasons be conservative and permits are issued in light of current population trend and habitat quality (Connelly et al. 2003).

Sage-grouse have been hunted legally in Utah since 1951. From 1951–1962, harvest was limited by issuing permits. Statewide harvest peaked in the late 1970s and early 1980s with the highest harvest at 28,280 sage-grouse in 1979 and the lowest harvest (1,303) occurring in 1967. Harvest for 2000 was estimated at 1,498 sage-grouse, reduced 77% from the 1999 estimate. The number of sage-grouse harvested per hunter has shown an overall decrease from 1967–2000 with the lowest rate of 0.31 sage-grouse/hunter attained during the 1997 hunting season. The number of sage-grouse harvested per hunter-day has also shown a decline from 1967–1999 (UDWR 2002).

The UDWR reduced the number of sage-grouse hunting units in 2000 due to declining populations. Currently, there is no legal hunting of sage-grouse in the Resource Area. Illegal harvesting of sage-grouse likely occurs at a low level in the Resource Area, however we have no documentation of this activity. In the future, communication and education regarding the natural history and status of sage-grouse may continue to maintain the relatively low levels of illegal harvesting. Additionally, the Resource Area may be considered for legal harvesting of sage-grouse in the future when populations are large enough to support such activity.

D. Incompatible Fire Management

Across the Intermountain west, fire suppression is believed to have caused sagebrush stands to increase in canopy cover and density with a resulting reduction or loss of herbaceous understory species in many areas. Sagebrush stands have become more even-aged and less productive across large areas of sage-grouse habitat. Fires that do start tend to burn greater acreage and at higher intensity due to the increased amount of fuel available to the fire. BLM fire data shows a rise in fire starts and acreage burned within the last 20 years (LSFO Fire Management Plan 2000).

The effects of any particular fire event depend on several characteristics of the local area including dominant sagebrush species, aridity, soils, topography, and disturbance (Bunting et al. 1987, Miller and Eddleman 2000). In general, sagebrush species are fire adapted and will recolonize an area after a burn. Other threats such as invasive/alien species (e.g. cheatgrass, *Bromus tectorum*), livestock grazing, and agricultural cultivation, are now present in sagebrush biomes and contribute to the frequency, intensity, and duration of fire disturbances.

Fire, in general, is not detrimental to sage-grouse. In fact, sage-grouse have been observed to use burned areas so long as suitable cover and food are present (Slater 2003). However, two altered fire regimes have emerged as being potentially incompatible with habitat management for sage-

grouse populations. In the first, invasion of cheatgrass has increased the frequency of fire disturbances, potentially changing sagebrush-steppe plant communities into grasslands (Miller and Eddleman 2000, Connelly et al. 2000). In the second, the occurrence of fire suppression has prevented the regular setback of succession and promoted the advancement of pinyon-juniper stands (Burkhardt and Tisdale 1969, Young and Evans 1981, Miller and Rose 1995, Miller et al. 2000). In these areas, there is the potential for sagebrush seed sources to be lost; reducing the likelihood that sagebrush could become reestablished after an eventual fire disturbance.

Today, cheatgrass and pinyon-juniper encroachment is not yet widespread within the Resource Area. Fire management by the BLM and the USFS is done in close cooperation with the UDWR who often provides a seed mix for post-burn rehabilitation. Fire planning is done carefully and cautiously in the Resource Area to reduce the threat of encroaching post-burn cheatgrass. Additionally, land management agencies are actively using mechanical techniques to remove juniper and pinyon pines that have invaded sagebrush-steppe communities and altered this ecosystem.

E. Incompatibility of Wildlife and Livestock Grazing

Livestock grazing is an important use of current and potential sage-grouse habitat in the Resource Area and throughout the range of sage-grouse in the West. The impact of concentrated livestock grazing on sage-grouse habitat is not clear, yet the debate is often contentious and controversial, perhaps more so than any other issue. Published literature and opinions run the gamut from completely compensatory or beneficial influence at one extreme, to a totally incompatible, harmful practice that should be eliminated (Connelly et al. 2005). Because of controversy and Rowland's thorough and recently published (2004) review on the subject, we have chosen to follow the lead of the Gunnison Sage-grouse Rangewide Steering Committee (2005) and simply provide several quotes from her Rowland's publication. In addition, the potential impacts of livestock grazing on sage-grouse are covered extensively in Connelly et al. (2005).

Concentrations of wildlife such as elk and wild horses have also been reported to detrimentally affect sage-grouse habitat. To date, there is no research available to determine the effects of this use on sage-grouse behavior. However, similar uses of the landscape by wildlife as those described by grazing livestock would likely have similar effects.

Impacts to Sage-grouse Habitat

Rowland (2004:17-19) noted cases where livestock grazing was reported to have had a positive effect:

“Some positive effects of livestock grazing were noted. When cattle were introduced into a meadow with residual grass, sage-grouse initially preferred the grazed openings, which had an effective cover height (*sensu* Robel et al. 1970) of 5 to 15 cm, compared to 30 to 50 cm in the lightly grazed surrounding areas. Grouse avoided dense, ungrazed basin wild rye meadows but were observed in adjacent wild rye that was grazed. One 40-ha meadow that was lightly grazed by cattle (41 yearling heifers, 60 days in June- August) was used throughout the

summer by sage-grouse and had more sage-grouse (100) than any other meadow on the refuge. Effective cover height in the meadow did not decrease below 5 cm during the summer.”

Rowland (2004:17–19) also summarized studies that suggest livestock grazing has a negative impact on sage-grouse habitat:

“Beck and Mitchell (2000) summarized potential effects of livestock grazing on sage-grouse habitats, and cited only four references that provide empirical evidence of direct negative effects of livestock grazing on sage-grouse, as follows. Of 161 nests examined in Utah, two were trampled by livestock (one sheep, one cattle) and five were deserted due to disturbance by livestock (Rasmussen and Griner 1938). In Nevada, sage-grouse habitat in wet meadows was degraded through overgrazing by domestic livestock and altered system hydrology (Oakleaf 1971, Klebenow 1985; as reported by Beck and Mitchell 2000). Klebenow (1982) examined sage-grouse habitat use in relation to grazing at the Sheldon NWR in Nevada, where sheep and cattle had grazed for > 130 yr. Dominant sagebrush species at the refuge were low sagebrush, mountain big sagebrush, and Wyoming big sagebrush. Grasses included Sandberg and Cusick’s bluegrass (*Poa secunda* and *P. cusickii*, respectively) in wet meadows, and Sandberg bluegrass and mat muhly (*Muhlenbergia richardsonis*) in dry meadows. A rest-rotation system was implemented for cattle grazing in 1980 over the majority of the refuge, where season-long grazing had occurred historically; a smaller portion had previously been managed under deferred rotation. Meadows heavily grazed by livestock (e.g., with few forbs and grasses and dense shrubs present) were avoided by sage-grouse, with the exception of use for free water when available (Klebenow 1982). (No explicit definitions were provided for light versus moderate or heavy grazing.)”

Impacts on Sage-grouse Behavior and Demographics

Studies that focused on sage-grouse behavior and demographic parameter response to grazing reported mixed impacts (Rowland 2004:17-19):

“Danvir (2002) reported two instances of nest abandonment related to livestock grazing in northern Utah during 7 yr of observations; one was caused by cattle, the other by sheep. Sage-grouse behavior on leks did not appear to be altered by the presence of cattle grazing (Danvir 2002). Sheep grazing in Idaho did not appear to disrupt use of leks by sage-grouse (Hulet 1983). Autenrieth (1981), however, cautioned against grazing sheep in sage-grouse winter habitat. He also suggested that livestock use of meadows occupied by sage-grouse, as well as livestock drives in sage-grouse habitat, could be detrimental to sage-grouse. In Wyoming, nesting densities of sage-grouse were considerably lower (10 nests/100 ha) in areas heavily grazed by domestic sheep compared to adjacent sites with moderate grazing (28 nests/100 ha) (Patterson 1952). Nest desertion caused by migrant bands of sheep also was documented (Patterson 1952). Heath et al. (1998) compared sage-grouse nesting and breeding success at three ranches with different grazing operations and levels of predator control in Wyoming. They found that,

despite heavier livestock use (removal of >50% of annual herbaceous production, and grazing by both sheep and cattle) and long-term predator control on one ranch, nesting and breeding success of sage-grouse did not differ substantially among the three sites. Chick survival to 21 days was, however, greater on the ranch with lighter grazing, suggesting that predator control did not fully compensate for the greater reductions in herbaceous production (Heath et al. 1998). Further, hens were documented leaving the more heavily grazed ranch to nest elsewhere but returning to that ranch to rear broods (Heath et al. 1998). In a similar study, Holloran (1999) examined sage-grouse habitat use and productivity in relation to grazing management strategies at four ranches in southeastern Wyoming. He found no differences in nest success, brood survival, or numbers of chicks fledged among the ranches. Some differences in habitat use by sage-grouse were found among the ranches; however, these could not be ascribed to differences in grazing pressure, but were ascribed to differences in soil types and precipitation patterns (Holloran 1999). Above-average precipitation during the study, however, may have obscured any potential differences in habitat suitability for sage-grouse among sites. Neither of these studies employed control sites or replication.”

Recommendations

In her extensive literature review, Rowland (2004:11) summarized recommendations found in the literature related to timing of grazing and reduction of impact to riparian areas used during brood-rearing. In addition, Rowland (2004: 24) made her own recommendations:

“Timing of grazing greatly influences the effects of livestock grazing in meadows and riparian areas. These sites are particularly vulnerable in late summer when excessive grazing and browsing may damage riparian shrubs, reduce the yield and availability of succulent herbs (Kovalchik and Elmore 1992), and cause deterioration of riparian function over time (Klebenow 1985). However, moderate utilization by livestock in spring, early summer, or winter is sustainable in non-degraded meadow and riparian areas within sagebrush habitat (Shaw 1992, Clary et al. 1996, Mosley et al. 1997). Moderate use equates to a 10-cm residual stubble height for most grasses and sedges and 5-cm for Kentucky bluegrass (Mosley et al. 1997, Clary and Leininger 2000). Shrub utilization should not exceed 50-60% during the growing season, and at least 50% protective ground cover (i.e., plant basal area + mulch + rocks + gravel) should remain after grazing (Mosley et al. 1997). While hydrophytic shrubs may not directly serve as sage-grouse habitat, they do impact the stability of riparian and meadow habitats important to sage-grouse (Winward 2000). The length of time livestock have access to meadows may be more important than the level of utilization; it has been suggested that livestock access be limited to 3 weeks (Meyers 1989, Mosley et al. 1997). In riparian and meadow habitat degraded by heavy livestock utilization, rest from grazing may be necessary for recovery (Clary and Webster 1989).

Manage livestock grazing through stocking rates and season of use on all seasonal ranges of sage-grouse to avoid habitat degradation (Paige and Ritter 1999, Beck and Mitchell 2000, Wisdom et al. 2000), especially on recently disturbed sites, such as those sprayed or burned (Braun et al. 1977). In nesting and brood-rearing

habitats, ensure that grazing does not reduce herbaceous understory cover below levels that serve as a deterrent to potential predators of eggs and chicks (Connelly et al. 2000b, Hockett 2002). Healthy native understories also support insects and forbs that are important in diets of pre-laying hens and chicks (Johnson and Boyce 1990, Barnett and Crawford 1994, Drut et al. 1994b). Riparian areas and wet meadows used for brood rearing are especially sensitive to grazing by livestock; in these habitats, removal of livestock before the nesting season may be prudent (Beck and Mitchell 2000, Hockett 2002).”

Livestock grazing is an important use of sagebrush rangelands in the Resource Area. Although some incompatible grazing likely occurs within the Resource Area, the majority of livestock operations appear to be coexisting with sage-grouse, and sage-grouse populations are stable to increasing. Personal observations have documented the simultaneous use of meadows by cattle and sage-grouse. Additionally, cattle have recently been used to improve habitat conditions for sage-grouse by improving the age-class distribution of the vegetation. However, no studies have been conducted in the Resource Area to measure the positive or negative effects of grazing on sage-grouse.

Similarly, there have been no studies published that examine the effects of wildlife grazing on sage-grouse habitat or behavior. However, use of habitat by wildlife or wild horses in a similar manner to those described by Rowland would logically have the same effect. Therefore, congregations of elk, pronghorn, deer, and/or feral animals such as wild horses around riparian areas or critical winter habitat should be avoided.

F. Incompatibility of Outdoor Recreation

The effects of off-highway vehicle (OHV) recreation and other forms of recreation (snowmobiles, birdwatching, etc.) on sage-grouse behavior and populations are poorly understood. Impacts of recreational activities are likely to be of two forms: disturbance of individuals and alteration of habitat.

Recreational activities, specifically OHV recreation, likely has the potential to impact individual birds or flocks of birds by flushing them from breeding grounds, nests, roost sites, or foraging areas depending on the season in question. Noise associated with OHV recreation is likely the primary cause of disturbance to individual or flock behavior. Disturbance during nesting season may result in nest abandonment or failure. Disturbance during any time of year may increase the vulnerability of sage-grouse to predators. OHV recreation, and other forms of recreation, may also trample plants, disturb soils, and otherwise alter and degrade habitat. In many instances, specific areas are designated for use of OHVs. When confined to specific use areas, impacts are likely to be reduced.

OHV recreation is relatively common in the Resource Area; however, specific impacts to sage-grouse populations are unknown, but thought to be minimal. Activities such as mountain biking, hiking, and other non-motorized sports are thought to have minimal or no negative effects on sage-grouse and their habitats. However, these activities are increasing in the Resource Area as the urban and suburban population increases. This increase in general human activity could potentially affect sage-grouse use of an area and thus should be monitored.

G. Cheatgrass and Invasive/Noxious Weeds

The Utah Department of Agriculture (Section 4-17-2) defines noxious weeds as "...any plant the commissioner determines to be especially injurious to public health, crops, livestock, land, or other property." At the federal level, an invasive species is defined as one which is not native to the ecosystem in question and whose introduction causes or is likely to cause economic or environmental harm, or harm to human health (Executive Order 13112, signed by President Clinton, 1999). Under the Utah Noxious Weed Act (4-17-10) county weed departments are charged to "...develop, implement, and pursue an effective program for the control and containment of noxious weeds on all lands under their control or jurisdiction, including highways, roadways, rights-of-way, easements, game management areas, and state parks and recreation areas."

Russian knapweed (*Centaurea repens*), dyers woad (*isatis tinctoria* L), and several other species of thistle, grasses, and knapweed are listed on the Utah Noxious Weed List (Section 4-17-3, Utah Noxious Weed Act). Cheatgrass, however, is not listed, nor is it included in individual county lists for Color Country Resource Area. Cheatgrass is an annual grass native to Russia and parts of northern Europe. When it invades sagebrush communities, cheatgrass increases fire frequency and has the potential to convert sagebrush communities to grasslands or annual grass rangelands. This increase in fire events leads to devastation of the native forb sandbank after which there are limited options for restoring the area to its native condition. Cheatgrass has also been reported to encourage establishment of other invasive species (Grahame and Sisk 2002). Thus, efforts at combating cheatgrass invasions are critical to maintaining sage-grouse habitat.

Invasive species affect the species composition, nutrient cycling, and physical structure of sagebrush systems. Invasive species also have impacts on the function of sagebrush systems, especially their ability to recover from fire. These impacts often culminate in an alteration of wildlife species diversity and abundance in these systems.

Noxious weeds are recognized within the Resource Area as a serious problem by County Weed Control departments, BLM, and USFS. County weed control departments maintain records of the location, extent, and severity of weed establishment, and actively work to control the spread and establishment of weeds in their respective counties. In January 1996, the BLM published Partners Against Weeds (PAW), an action plan for the Weed Management program in the Bureau. The PAW plan lists seven goals, the first being to develop a prevention and early detection program. The PAW recommends developing and enforcing a policy to "ensure seeds, seed mixtures, hays, grains and straws are free of weed seed" as a prevention and detection strategy. Utah's BLM Resource Advisory Council developed a guideline requiring certified weed free forage to be used on BLM lands by anyone having the need to take forage with them when using BLM public lands. Both the Utah State Director and the Secretary of the Interior approved the guidelines in 1997. Since 2002, users of all federal lands and trust lands in Utah are required to use only certified noxious weed -free (cheatgrass is not considered a noxious weed) hay, straw, or mulch. The USFS is also committed to a campaign against the spread of invasive species. Working with agency and local government partners the USFS aims to create Cooperative Weed Management Area (CWMA) Participative Agreements for all USFS lands.

H. Communication among Responsible Parties

The impact of a lack of communication among management agencies such as the BLM, USFS, UDWR, and other responsible parties such as county and city planning commissions is intangible. Additionally, lack of communication to the interested public is a lost opportunity for the understanding and partnerships needed to properly manage all the issues that arise with developing a sage-grouse management strategy. Without proper communication, each management agency maintains a separate database concerning vegetation treatments, sage-grouse population counts, and critical habitat locations. Thus, implementation of strategies would possibly be repetitive and an inefficient use of available funds. Much damage due to the threats discussed in this analysis (i.e., development, recreational uses, and vegetation treatments) may be avoided or diminished with the guidance of a working group involving representatives from the entire community.

I. Parasitism and Disease

Several bacterial and parasitic diseases may affect sage-grouse to varying degrees. Sage-grouse have long co-existed with a range of pathogens and many produce no or few ill effects in individuals and populations. Large-scale (i.e. rangewide or statewide) impacts to sage-grouse have not been reported. Below, we discuss a few of the pathogens that appear most likely to impact sage-grouse populations (Connelly et al. 2005).

West Nile Virus

West Nile virus (WNV) is an arbovirus, or arthropod-borne virus, of the flavivirus family, which also includes Dengue and Yellow Fever. WNV is one of many mosquito-borne viral infections. Mosquitoes of the *Culex* family primarily transmit West Nile Virus during normal blood feeding. Some species in this family feed primarily on birds, which act as reservoirs or amplifying hosts of the virus. Although many species of birds are known to contract WNV, species in the Corvid family (crows, ravens, and jays) are more susceptible to the disease and are therefore useful geographic detectors of WNV. Mammals, including humans and horses, are considered incidental hosts and are therefore viral “dead ends.” Humans are most likely to acquire WNV from an infected mosquito. Other mammals, such as horses, do not maintain a high enough level of the virus in the blood stream to transmit the virus to humans.

WNV was first detected in the Western Hemisphere in 1999 and has since rapidly spread across the North American continent into all 48 continental states, seven Canadian provinces, and throughout Mexico. In addition, WNV activity has been detected in Puerto Rico, the Dominican Republic, Jamaica, Guadeloupe, and El Salvador.

In 2003, several cases of WNV were confirmed in sage-grouse in Wyoming (19 birds), Montana (3 birds), and Alberta, Canada (5 birds). In that same year, WNV was detected in chickens in Price, Utah and in mosquito pools in the Uintah Basin. In 2004, sage-grouse in Wyoming, Montana, Colorado, and California tested positive for the virus. In 2005, the virus was confirmed in a dead sage-grouse in the Uintah Basin and also in a prairie falcon in Carbon County. A limited percentage of sage-grouse appear to be capable of developing immunity to the virus (Cornish, unpublished data) and infection appears to be almost always fatal within 24-

48 hours.

Macro-parasites

Coccidiosis—Coccidiosis is an intestinal disease caused by one or more species of the protozoan genus *Emeria* (Jolly 1982): *E. angusta*, *E. centroceri*, and *E. pattersoni*. Infection results in diarrhea caused by damage to the mucosal lining of the digestive tract. The disease is transmitted through consumption of contaminated feces. Coccidiosis is the most well known of all diseases infecting sage-grouse (Connelly et al. 2005). In Wyoming, Colorado, and Idaho from 1932–1953 this disease resulted in significant losses of young sage-grouse (Honest and Post 1968). No cases, however, have been documented since the 1960s (Connelly et al. 2005). Cases were typically reported in areas where large numbers of birds are concentrated. The concentration led to contamination and spread via water and food sources. Connelly et al. (2005) speculated that this disease lacks prevalence in recent years because sage-grouse density has decreased. No cases of Coccidiosis are known from the Resource Area; however this does not imply that the condition does not exist or have the potential to exist. Specifically, drought conditions that result in a decrease in water sources may potentially increase sage-grouse concentrations in localized areas, thereby increasing the potential for impacts from this infection.

Tapeworms—Sage-grouse are the only known host of the cestode tapeworm *Raillietina centroceri* (Honest 1982). There is little consensus on the impact *R. centroceri* have on sage-grouse populations. The Canadian Sage Grouse Recovery Strategy indicates that this infection may be a largely overlooked cause of mortality. Still, Honest (1982) suggested that there was a synergy between host and parasite with little negative impacts to sage-grouse. The parasite does not affect the quality of sage-grouse meat. There are no documented cases of *R. centroceri* in the Resource Area however; this does not imply that this infection does not affect sage-grouse therein.

Filarid Worms—A filarial nematode, *Ornithofilaria tuvensis*, which utilizes the connective tissue between skin and breast muscle in sage-grouse, appears to prevent flight in infected birds (Hepworth 1962). This infection is rare but appears to have significant impacts. This infection is not known to occur in the Resource Area; however, it may yet exist, undetected.

Avian Malaria—Avian malaria, caused by the protozoan *Plasmodium pediocetti*, is known to infect wild sage-grouse but is considered rare. Although this infection does not have a profound impact on sage-grouse populations, it does cause birds to reduce activity during morning hours and may influence courtship and breeding of strutting males (Boyce 1990, Johnson and Boyce 1991). Biting flies (Friend and Franson 1999) transmit this disease.

Conclusions

We currently consider WNV to be the disease/parasite with greatest potential to affect sage-grouse populations in the Resource Area. As previously mentioned, in 2005 a dead sage-grouse infected with WNV was found in eastern Utah. Additionally, parts of Colorado and Wyoming have also detected infected birds. Thus, there is potential for the disease to spread into the Resource Area.

As previously mentioned, other diseases discussed in this section may have an effect on sage-

grouse but have not been documented in the Resource Area and, therefore, do not pose as great a potential threat.

J. Predation

Sage-grouse occupy an important place in the food web in sagebrush environments and are preyed upon by a wide variety of terrestrial and avian predators. Numerous predators have been documented preying upon differing ages of sage grouse and/or their nests. Documented nest predators include weasel, badger, elk, coyote, common raven, American crow, red fox, striped skunk, black-billed magpie, and various species of snakes (Batterson and Morse 1948, Patterson 1952, Nelson 1955, Autenrieth 1981, Hanf et al. 1994, Young 1994, DeLong et al. 1995, Sveum 1995). Numerous species have also been documented killing and/or consuming adult sage-grouse and include Cooper's, ferruginous, red-tailed, and Swainson's hawks; Northern goshawks, coyote, red fox, and bobcat (Girard 1937, Rasmussen and Griner 1938, Batterson and Morse 1948, Nelson 1955, Rogers 1964, Beck 1977, Dunkle 1977, Autenrieth 1981). Numerous predator species, many of which are listed above, have been documented to kill juvenile sage-grouse. Because of the small size of young sage-grouse, additional predators have been documented and include American kestrels, merlin, Northern harrier, common raven, and weasel (Girard 1937, Patterson 1952, Nelson 1955, Rogers 1964, Autenrieth 1981).

Predation is the end result for the vast majority of sage-grouse throughout their range, both historically and presently (Bergerud 1988). Schroeder and Baydack (2001:26) suggest that predation has the potential to affect the annual life cycle of sage-grouse in 3 primary ways: 1) success of nests; 2) survival of juveniles during the first few weeks after hatch; and 3) annual survival of breeding-age birds." Peterson and Silvy (1996) conclude that the relative importance of predation on the viability of sage-grouse populations is relatively unknown and needs further study.

Nest success varies by year, area, population density, and/or management strategy (Connelly et al. 1998, Schroeder et al. 1999). Connelly et al. (2000) suggested that several studies on nest success have illustrated success > 40% and that nest predation does not appear to be a problem across the range of the sage-grouse. In contrast, Gregg (1991) and Gregg et al. (1994) suggested that nest predation might be limiting grouse numbers in Oregon. Red foxes and common ravens have been implicated in affecting nest success and the annual survival of breeding age birds in the Strawberry valley area of Utah (Bunnell 2000). Researchers suggest that the advancing population of a nonnative predator, red fox, is responsible for preying upon a large portion of the population in that area (Flinders 1999). In artificial nest studies conducted in Strawberry Valley, ravens depredated 98% of artificial nests within 48 hours of their placement. Remote cameras were used to verify the identity of artificial nest predators (Baxter and Flinders, unpublished).

History of Predator Management in Utah

The following sections on the history of predator management and effects of predator management on sage-grouse populations were written, in conjunction with CoCARM, for the Plan by representatives from USDA-WS. Wildlife Services has been managing predator populations and collecting data on predator population trends in the state for several decades.

They also have an extensive body of personal knowledge about predator population management and the impacts of various management practices.

Understanding the impact of predation on sage-grouse is difficult, as the primary effects (the number of sage-grouse killed by predators) is affected by habitat variables, variables associated with the predator population, and variables within the sage-grouse population itself. Secondary effects of predation exist and are indicated when habitat choices are dictated by the risk of predation. What we currently know about habitat needs of sage-grouse is developed from studies of core sage grouse range. However, if predation or the risk of predation is effecting habitat selection, then otherwise good habitat is made unavailable to sage-grouse. To more completely understand the role predation management may have played historically, it is important to examine records of the past.

Predator management in Utah began in the late 1800s with territorial bounties followed by a federal appropriation in 1917. The original purpose for the federal program was the suppression of rabies. The program has gone through several changes with both State and Federal agencies involved. The US Biological Survey managed predator control in early years and developed the structure that was later used by the USFWS, which is to have supervised men in designated Wildlife Services districts (districts). From 1936 to 1986, the USFWS managed the program as Animal Damage Control. In 1986, it was moved to the United States Department of Agriculture under the Animal and Plant Health Inspection Service and in 1996 was renamed as Wildlife Services (again; USDA-WS).

Correlations exist between livestock inventories and the intensity of predator management efforts. Domestic sheep numbers are recorded (Utah Agricultural Statistics) at a high of 2.7 million in 1931. Breeding sheep inventories as of January 1, 2003 were reported at 290,000 head, or 10.7% of the maximum number. Sheep numbers varied from year to year in some cases, and from decade to decade since the early 1900s. Toxicants were used extensively in the early years when sheep numbers were high. Additionally, predator management in the early years involved many trappers setting and tending steel traps statewide. As many as 132 men were hired (1936) to set and bait traps. Figure 6 shows the recorded take of coyotes from the predator control program between 1917 and 2004. These data do not include poisoned coyotes, which were not found but estimated as 7-10 coyotes for each one found.

Strychnine and thallium treated single lethal dose (SLD) baits were the main toxicants used between 1920 and 1950. Compound 1080 was developed around 1945, first as a rodenticide and later as a predicide in large bait stations. USDA-WS records indicate that 1443 bait stations were applied in 1969, covering 54% of the townships in the state. Bait placement from 1950 to 1972 were large bait stations while SLD baits were used prior to that. From about 1950 to 1972, Compound 1080 became the main force in controlling coyotes in all districts of Utah by the government and by private individuals. The low government take of coyotes during this period indicates that coyote populations were suppressed by bait station use. Toxicants were banned in federal programs in 1972 and current policies allow only two very selective toxicants and then only for limited use.

Early predation control also extended to ravens, crows, eagles, and magpies. Records indicate that single baits were applied around “draw stations” to target birds. Records also note that UDWR personnel targeted areas for bird suppression that were not treated by the federal

program.

It is difficult to assess the poison years in terms of suppressing populations of species such as ravens, coyotes, and even red foxes. Individual species records are presented below:

Red Fox—While some early records of red foxes exist, red foxes are believed to have been virtually absent on the landscape before the 1970s. Red fox do not exist in government records before 1972, and have increased since then. Red foxes may have been successfully suppressed by rabies or by bait station use, or possibly both. Figure 7 shows red fox take from 1972–2004.

It is interesting to observe that the statewide increase in red fox abundance has occurred during the lowest period of coyote control. Sargeant (1984, 1987) theorizes that protection for coyotes would allow coyote populations to increase, thus suppressing red fox populations. This has not happened on a landscape basis in Utah.

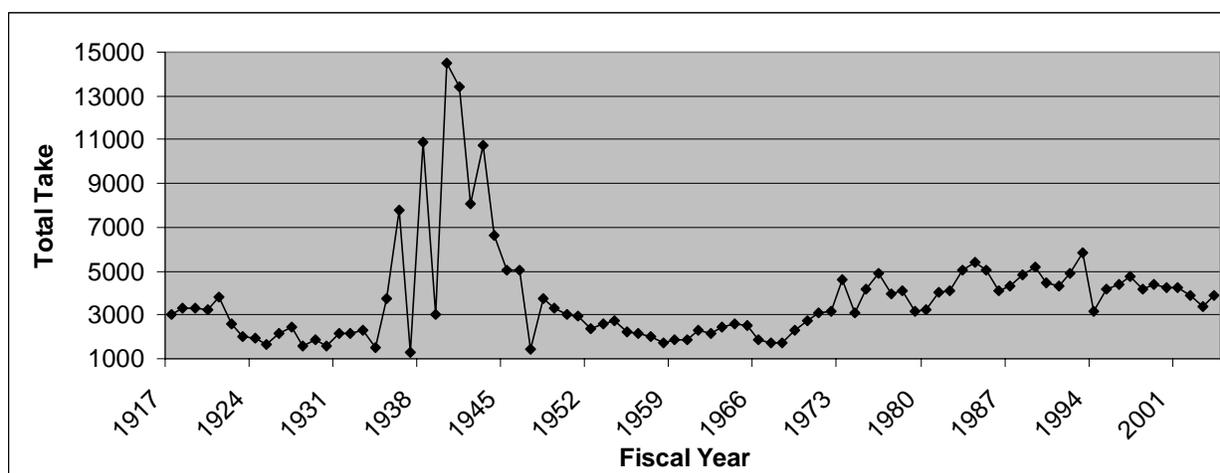


Figure 6. USDA-W.S. reported coyote take in Utah, 1917–2004.

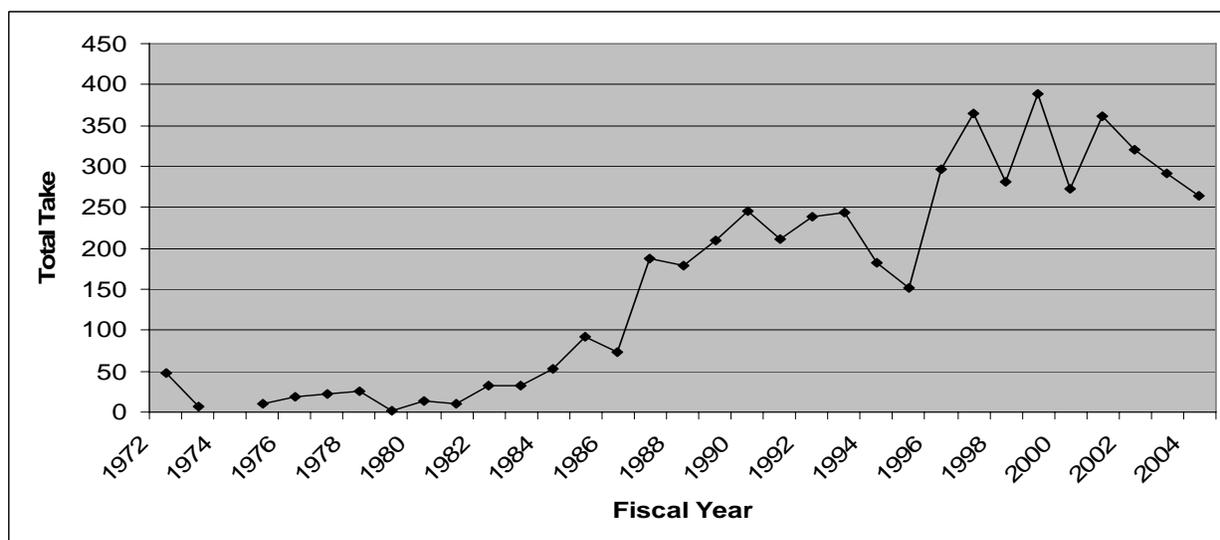


Figure 7. USDA-W.S. reported fox take in Utah, 1972–2004.

An argument may be made that red fox in Utah are an invasive species based on historical data. Red foxes were historically divided into two species, *Vulpes vulpes* in the Old World and *V. fulva* in the New World, but today they are considered to be one species in the U.S. (*V. vulpes*). Churcher (1959) reviewed twelve subspecies of red foxes in North America with nine subspecies currently recognized in Canada. Churcher (1959) suggested that the red fox was introduced from Europe to the southern colonies around 1790.

Following the introductions there was confusion as to which populations were expanding. Audubon and Bachman (cited in Churcher 1959) believed that Pennsylvania was the southern limit of the red fox's range in 1750 and documented a range extension southwards to Georgia by 1850. Leopold (1935) reported the expansion of red fox in Wisconsin which was displacing the grey fox, and Godin (1977) reported *V. fulva* had established itself by 1850 and was displacing the gray fox to some degree along the southeastern seaboard. Godin also speculated that the introduced foxes might have interbred with a scarce population of indigenous red foxes, but historical accounts do not support this. Churcher (1959) concluded from the available evidence that the red fox was native to North America north of 40-45 degree N but was scarce or absent in the hardwood forests where gray foxes were common. Churcher (1973) suggested that the "original" habitat was the northern mixed hardwood and softwood forest zones; he also observed that the red fox might have been found in the hardwoods to the south and the tundra to the north. Gilmore (1946) believed that red foxes were absent from Pennsylvania during aboriginal times and concluded that they did not range into the mideastern United States. Rhoads (1903 cited in Churcher 1959) stated, "In earlier colonial times the red fox was unknown in the austral zone (southern states).

Archaeological evidence from Ontario, Canada (Peterson et al. 1953) has shown that the red fox was present in the Midland area prior to introductions during the decade 1639–49 and that it was present earlier in the Oxford and Middlesex counties of southern Ontario, Canada. Sites farther south did not have red foxes (Gilmore 1946).

Once the red fox began to spread south and west from northeastern U.S. after its introduction from Europe, it expanded its range to include the prairies of the Midwest and continued to expand west to Colorado and Utah. It has reached the Utah-Nevada line and seems likely to invade Nevada as well.

Striped Skunk—Historically, what may be significant is the relatively few skunks found in Utah. Figure 8 shows skunk take by USDA-WS in Utah from 1917–2004. Periodic rabies eruptions suppressed skunk populations in the early years of the century. As an example, in 1918 with 51 full time personnel setting traps, only 10 skunks were removed statewide. In the 1920s, following years of SLD bait placements, skunk take in the program increased to above 100 annually, but then declined to none in 1933, 12 in 1934, 35 in 1935, and up to 98 in 1936. The cycle of skunk removal probably reflects the population level effect of rabies in skunks. The last skunk rabies incident in USDA-WS records occurred in 1972 in Davis County, with a countywide control program initiated as a result.

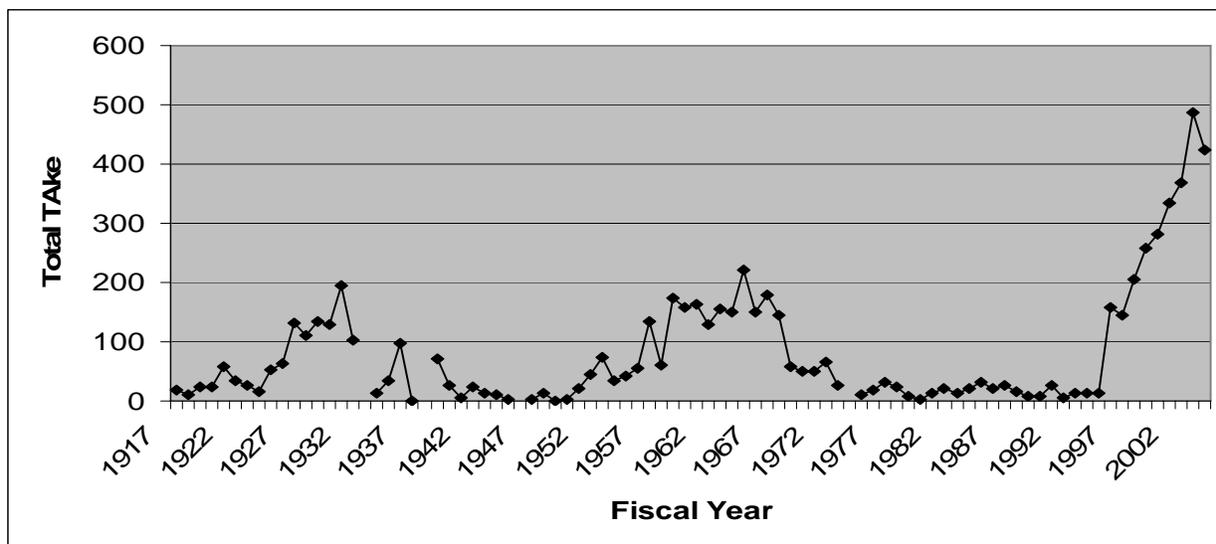


Figure 8. USDA-WS reported skunk take in Utah, 1917–2004.

Raven and Magpie—Breeding bird survey results indicate a 300% increase in raven numbers from 1968 to the present. While most biologists believe the increase is due to more favorable conditions and anthropogenic food sources, the increase in populations also follows the reduction in use of poisons, which likely kept their numbers low.

Magpies were targeted along with ravens at draw stations with smaller baits placed especially for birds. USDA-WS records show that UDWR personnel placed baits to target birds in areas where federal poison programs were not active.

Coyote—Intensive coyote control prior to 1972 suppressed coyote populations. Since that time, the design of the predation management program has been to reduce coyote damage while not impacting populations. Analyses by Connolly and Longhurst (1975) and Pitt et al. (2002) indicate that the current level of exploitation does not affect coyote populations. It seems likely that coyote populations have never been higher than in modern times.

Impacts of Predation on Sage-grouse

Given that predators and nest predators are abundant and many are present in all time high numbers, impacts to sage-grouse may take one of two forms. Sage-grouse may be killed directly by predators (primary effects), and most mortality of sage-grouse is predation. Direct predation has negative population effects when it exceeds recruitment.

Secondary effects of predation include biological effects, which are the result of behavioral changes in sage-grouse. These behavioral changes result from the risk of predation and may take the form of lower fecundity, longer dispersals, use of suboptimal habitat, nest abandonment, and a number of other behaviors that may affect populations.

Autenrieth (1981) suggested that nest predation was likely the most important population constraint on sage-grouse though predation on adult birds does occur and may be significant in some cases. Presnall and Wood (1953) reported tracking a coyote approximately five miles to its

den in northern Colorado, and finding evidence along the way that the coyote had killed three adult sage-grouse and destroyed a sage-grouse nest. Examination of the stomach contents from an adult female coyote removed the next day showed parts of an adult sage-grouse plus six newly hatched sage-grouse chicks. The area around the den site was littered with sage-grouse bones and feathers. No other prey animal remains were found around the den, and it appeared that the pups had been raised largely upon sage-grouse. Till (1982) documented sage-grouse remains at four of the thirty coyote den sites examined during his study in south central Wyoming, but provided no indication of the relative abundance or distribution of sage-grouse in his study area. In northern Utah, researchers from Brigham Young University (BYU) confirmed predation, primarily by red fox and coyote, as the cause of death for 13 of 21 radio-instrumented sage-grouse in the first year in their study area (Bunnell and Flinders 1999). Two additional instrumented birds could not be found but were suspected to have been killed by predators, suggesting a 71% predation loss of instrumented birds. Additionally, eleven other sage-grouse were found dead in their study area, and all but one of these birds were killed by mammalian predators. USDA-WS is not aware of controlled studies conducted to determine if coyote and red fox control would actually result in significant benefits to sage-grouse populations. However, the above studies indicate there may be some benefit to the removal of these predators in some situations

In addition to primary predation affects, secondary predation impacts likely exist in a number of populations. The risk of coyote predation may cause habitat abandonment or, through habitat choices, reduce fitness and make grouse more susceptible to other mortality. Coyote damage management may be indicated for populations not performing to habitat potential.

Meso-predator Release—As red fox have been implicated as primary predators of sage-grouse in many areas, the notion of some natural control of red fox by coyotes has been suggested. The idea that coyote removal may benefit red fox, and thus be a detriment to sage-grouse, has been offered by some as a need to limit coyote removal. The potential for an indirect affect on sage-grouse by coyote removal would take the form of a "meso-predator release" which is the increase in smaller mammalian carnivore species after larger carnivores have been reduced or eliminated. The meso-predator release theory allows that smaller predators are allowed to increase due to either a lack of predation or release from competition or both. Gehrt and Clark (2003) present an opposing view of meso-predator release and point out several weaknesses in the circumstantial evidence that has been used to suggest that meso-predator release occurs.

Sargeant, et al. (1984) reported on the effects of red fox predation on breeding ducks. Their data were collected when coyote populations were presumably suppressed by widespread use of predicide, and he notes that at the time (1968-73), "[c]oyote populations in most of the mid-continent area appear to be suppressed by man." The authors noted an inverse relationship between red fox and coyote populations and speculated, "...protection of coyotes will result in expansion of local or regional populations that in turn will cause reductions in fox populations." They inferred that this would reduce predation on upland nesting ducks. Sargeant et al. (1987) reported on spatial relationships between coyotes and red foxes and showed that home ranges of fox families did not overlap the core centers of coyote home ranges on a North Dakota study site. Although none of their radio-collared foxes were killed by coyotes in their study, they hypothesized that red foxes tended to avoid coyote territories, presumably to avoid being killed by coyotes. Thus, they inferred that a red fox population would increase if the coyote population were reduced because the removal of territorial coyotes would create vacant coyote territories

that could then become occupied by red foxes.

The presence of coyotes does not completely displace red foxes, however. Voigt and Earle (1983) verified that red fox travel through coyote areas during dispersal but did not establish there. They also reported that, "...individual foxes and coyotes can occur in close proximity to each other along territory borders and when coyotes travel into fox areas." They also noted that "fox-coyote range overlap near borders was similar to fox-fox range overlap near borders," and that coyotes do not "completely displace foxes over areas." Gese et al. (1996) reported that coyotes tolerated red foxes when encountered about half of the time in Yellowstone National Park although at times they were aggressive toward, and would sometimes kill, foxes.

Other studies suggest that coyote territories would not remain vacant for long after coyotes are removed. Gese (1998) noted that adjacent coyote packs adjusted territorial boundaries following social disruption in a neighboring pack, thus allowing for complete occupancy of the area despite removal of breeding coyotes. Blejwas et al. (2002) noted that a replacement pair of coyotes occupied a territory in approximately 43 days following the removal of the territorial pair. Williams et al. (2003) noted that temporal genetic variation in coyote populations experiencing high turnover (due to control) indicated, "...localized removal did not negatively impact population size..." When we consider the level of coyote removals of USDA-WS coyote damage management activities (2-4% of the estimated population) it is likely that coyote populations are probably not affected enough, even at the individual territorial level, to create the vacant territories that would theoretically allow red fox populations to increase substantially at the local level based on the North Dakota studies discussed above. Therefore, we believe it would be unlikely for USDA-WS coyote removal actions to lead to indirect increases in predation effects on grouse populations. To the contrary, where populations are not performing to the full potential of the habitat, predation management may be necessary as part of applied management for sage-grouse.

Predation Defense Mechanisms—Sage-grouse have adapted to live, and have evolved with, many of these predators. Sage-grouse and other ground nesting birds have developed effective strategies for hiding from predators when they occupy habitat of sufficient quality. Schroeder et al. (1999) briefly describe some of those adaptations. The actual timing of the strutting display and/or the formation of leks may have evolved due to predation selective pressures (Patterson 1952, Hartzler 1972, Bergerud 1988a, Phillips 1990). Sage-grouse also avoid predation by either crouching in dense vegetation or flying away from an attacking predator (Hartzler 1972, Ellis 1984). Female Greater Sage-grouse have also been documented defending their nests from ground squirrels (Schroeder 1997). Girard (1937) observed females attacking predators in the defense of their brood. In an attempt to lead potential predators away from nests and young chicks, females have been documented performing distraction displays. The distraction display includes dragging wings on the ground while moving erratically (Peterson 1980). In addition, a female will occasionally re-nest if predators destroy her first nest early in the incubation period (Patterson 1952, Eng 1963, Connelly et al. 1993, Schroeder 1997). Still, re-nesting rates for sage-grouse are relatively low (Connelly et al. 1993).

Predator Control and Livestock Populations

Predator control activities began in Utah in 1888 with Territorial Bounty laws, which continued into Statehood and through the early 1900s. The inauguration of the government sponsored

predator control program began in 1915 with small appropriations of funds used to hire a supervisor and eight men in designated areas where control was needed to protect livestock. Today the program is managed by USDA-WS.

Utah sheep numbers were at a record high of 2.7 million in 1931. Numbers varied annually in some cases and from decade to decade since the early 1900s. Today, approximately 265,000 sheep graze in Utah. Although sheep numbers are down, today more cattle ranching operations exist in the state compared to 1931.

With the arrival of more cattle, predator control was reinvigorated after having been relaxed due to reduced sheep numbers. Improved methods of hunting with aircraft increased efficiency and effectiveness since the early 1970s, but poisons were used extensively in the early years when sheep numbers were high. Congress passed the Animal Damage Control Act of March 2, 1931. Records show that in 1936 up to 132 men were hired for predator control. Poison baits placed by men in the various field districts were more effective at controlling predator populations over a larger area than are currently worked today. Government trappers took a documented figure of 16,719 predators in 1939 and that figure does not reflect all of those poisoned. This amount was a record catch for any one fiscal year and shows more predators were taken in early years than records of today. The number of predators taken during this era not only exceeds the modern “take,” but also likely represented a larger percentage of the population of the day. Modern records (since 1972) show that on average, USDA-WS in Utah takes about 5,000 coyotes per year by using 25 field men and several fixed-wing aircraft along with contracted helicopter work. Another 5,000 coyotes (on average) are taken by private hunters and trappers annually in Utah.

The coyote population in Utah today is near 100,000, based on studies by USDA-WS research personnel (Connelly 1996). Predator damage management today focuses on individuals causing damage, as opposed to the large-scale population reductions (or eradication in the case of the wolf) of the past. Current control is practiced on less of the land mass, with more restrictions and for the protection of fewer livestock, than at any time in Utah history. Correspondingly, there are probably more coyotes alive today than at any time in Utah history.

Strychnine and thallium were the main poisons used in the early 1900s until the advent of Compound 1080 in about 1945. Compound 1080 was first effectively used on rodents and later on predators. From about 1950 to 1972, 1080 became the main method in controlling coyotes in all districts of Utah by the government and by private individuals. It is impossible to know precisely the effects it had on the coyote population, as population censuses were not conducted and the main objective of control was eradication.

It is reasonable to believe that Compound 1080 reduced coyote numbers considerably in large tracks of land that are no longer controlled because current land use practices prohibit coyote control. Strychnine baits used for coyote control before 1972 (in conjunction with Compound 1080) likely controlled ravens and raptors that fed on the baits. Compound 1080 is highly selective to canines but was overused by most of the applicators because there were no dosage restrictions or regulations in place.

It is difficult to assess the extent of population suppression for ravens, coyotes and even red foxes during the poison years. Some red foxes were found in Utah in low numbers and at high elevations early in the Territorial history. However, most biologists believe the red fox in Utah

today, is an invasive species that arrived in the 1970s. Ravens have increased in numbers from the 1970s likely because of more favorable conditions including human-created food sources such as landfills. The increase in the raven population also follows the reduction in use of poisons that could have kept their numbers low. Early records show raven predation on lambs in the 1950s and public concern to control them.

The effects of reduced coyote control on sage-grouse are not well understood. The decline of sage-grouse occurred at the same time as coyote populations expanded. It could be concluded that the poison ban allowed coyotes, raptors, and ravens to expand in population numbers and range. At the same time, protections were placed on ravens and magpies through the removal of bounties and addition of laws that prohibited shooting and nest destruction. In addition, red foxes arrived and expanded in numbers because of the more favorable environments as previously discussed.

Incidentally, sage-grouse could also have benefited from the high numbers of sheep concentrated in winter areas. Proper sheep grazing in the winter has the effect of rejuvenating sagebrush. As sheep numbers declined, sagebrush became decadent to some degree. Although natural cycles may have once occurred in sage-grouse populations, change in the environment since the 1970s has caused a long-term decline. Once a decline in sage-grouse numbers occurred, the increase in predator numbers, especially red fox and ravens, would be more detrimental to the grouse.

Conclusions

No empirical evidence is available specifically related to the effects of predation on sage-grouse in the Resource Area. Many of the sage-grouse predators discussed above are known to occur in the Resource Area. USDA-WS does conduct predator control in the area related to livestock operations, which is likely to influence predator-prey dynamics involving sage-grouse. Under these management conditions, sage-grouse numbers in the Resource Area are increasing or stable and, given current circumstances and management actions, predation by native predators, excluding ravens in some instances, is considered a moderate threat to sage-grouse populations in the area. Predation by nonnative predators, including domestic animals, red foxes, and raccoons, and native (but anthropomorphically inflated) raven populations, is an issue of greater concern when the cumulative effects of increased nonnative predator populations, habitat fragmentation, reduced habitat quality are considered. Nonnative red fox populations have decimated relatively isolated populations of sage-grouse in Strawberry Valley, Utah (Bunnell et al. 2000), and there is some concern that increasing populations of red foxes and raccoons in the Resource Area could have a negative impact on sage-grouse populations.

K. Vegetation Management

Vegetation management conducted in the past was a reflection of the priorities of the time and the mandates and policies of the federal government concerning management of federal land. Because much of the land in the Resource Area is under federal management, this is an important consideration when evaluating past and current conditions. In the past, many vegetation treatments were conducted to increase forage for livestock.

Recently, vegetation management has increasingly focused on restoring health to sagebrush

rangelands. Management is increasingly performed in a proactive manner. For example, seeing controlled burns to prevent the establishment of nonnative plants, setting back succession in sagebrush stands to create a mosaic of sagebrush cover classes across the landscape, and adjusting grazing practices to retain tall grasses for nesting cover. Habitat management also involves treatments designed to remove cheatgrass and other invasive/noxious weeds, removal of pinyon-juniper stands, and restoring native species.

Several treatment types are used to manipulate sagebrush communities. Connelly et al. (2005:7-46 to 7-50) describes the mechanical, chemical, and biological techniques available and discusses their successes and challenges.

Given the current climate of vegetation management (i.e. restore/maintain the plant/wildlife community health), vegetation management is not likely to affect sage-grouse populations in the Resource Area. As discussed in an earlier section of this Plan, several habitat management projects have been implemented and are proposed for 2006, which are designed to improve sage-grouse habitat. Further, the Utah Partners for Conservation and Development (UPCD), a collection of resource management agencies, NGO, and private individuals recently established a Regional Team in the Resource Area. The purpose of the UPCD Regional Team is to increase communication, coordination, and sharing of resources and information regarding habitat and watershed improvements in the Resource Area. Increased focus and coordination is likely to improve project planning, implementation, and outcomes.

No empirical data exists regarding how sage-grouse have responded to vegetation treatments in the Resource Area. Several thousand acres have been treated in the Resource Area with the intent of improving sagebrush-steppe habitat (Table 3). We are not aware of post-treatment data that indicates the treatments resulted in conditions preferred by sage-grouse; however, that does not mean that those conditions do not exist or that the treatments were unsuccessful. Overall, we feel there is need to more rigorously monitor vegetation treatments in the Resource Area to expand our understanding of the effects of vegetation management on sage-grouse populations and habitats in the Resource Area.

V. Conservation Strategy

One of the main purposes of this Plan is to provide a framework of strategies and associated actions that can be implemented to abate threats, address information gaps, and guide monitoring efforts. Strategies and actions listed below (the order is irrelevant) were developed by CoCARM partners. Several other documents and publications provide recommendations and guidelines for management of sage-grouse populations and their habitats, many of which were reviewed in the Introduction of this Plan. Strategies developed by CoCARM are designed to be specific to the local area while taking into consideration the guidelines at a rangewide level.

Implementation of strategies and actions is strictly voluntary on the part of CoCARM partners. Despite this, we have designated for each strategy the public and private partners who might be involved in implementation. Designation does not imply responsibility or commitment of resources of any sort to implementing, initiating, or completing any actions; however, it does provide a framework of resources and expertise.

A. Strategies and Actions

1. **Strategy:** Reduce threat of predators on sage-grouse over ten-year period.
 - 1.1 **Action:** Determine predator community composition and depredation rate.
 - 1.2 **Action:** Avoid creating or improving raptor-nesting habitat in sage-grouse habitat. Remove raptor perches when possible.
 - 1.3 **Action:** Determine brood-rearing success in each focus area annually.
 - 1.4 **Action:** Enlist Wildlife Services to reduce population numbers of problematic predator species.
 - 1.5 **Action:** Support current predator management efforts by other groups or agencies in the focus areas.
Partners: USU EXT, UDWR, WS, land developers
Threats Addressed: Enhanced native and domestic predators
Aspects of Sage-grouse Ecology Addressed: Reduced nesting/early brood-rearing habitat quality, reduced summer/late brood-rearing habitat quality, reduced connectivity of seasonal habitat types, reduced connectivity of populations and sub-populations, reduced population size
2. **Strategy:** Improve age distribution of plants within sagebrush-steppe communities by 2016.
 - 2.1 **Action:** Identify and prioritize target areas needing improvement.
 - 2.2 **Action:** Coordinate among agencies and landowners to fund implementation of projects and monitoring.
 - 2.3 **Action:** Monitor the response of sage-grouse to changing habitat conditions.
Partners: USU EXT, UDWR, USFS, BLM, SITLA, NRCS
Threats Addressed: Invasive/alien vegetation species, fire and vegetation management, dramatic weather events
Aspects of Sage-grouse Ecology Addressed: Reduced connectivity of seasonal habitat types, reduced connectivity of populations and sub-populations, reduced nesting/early brood-rearing habitat quality, reduced summer/late brood-rearing habitat quality
3. **Strategy:** Improve water availability and riparian habitat in brood-rearing habitat by 2016.

- 3.1 **Action:** Survey and evaluate current water sources and needs.
- 3.2 **Action:** Partner with watershed specialists to identify new water sources.
- 3.3 **Action:** Consider new water developments that are multi-use and multi-purpose.
- 3.4 **Action:** Coordinate with private landowners to protect current water availability that benefits brood-rearing habitat.

Partners: NRCS, BLM, UDWR, USFS, landowners, interest groups

Threats Addressed: Concentrated wildlife and/or livestock use, dramatic weather events, alternative land uses (mining, wind power, water development)

Aspects of Sage-grouse Ecology Addressed: Population distribution, reduced nesting/early brood-rearing habitat quality, reduced summer/late brood-rearing habitat quality, reduced connectivity of seasonal habitat types, reduced connectivity of populations and sub-populations

4. **Strategy:** Increase participation of public and private landowners within the Resource Area.

- 4.1 **Action:** Develop partnerships with landowners and interest groups to increase visibility of sage-grouse management.

- 4.1.1 **Action step:** Identify regional groups and their contact person.

- 4.2 **Action:** Develop fact sheet to distribute to special interest groups.
- 4.3 **Action:** Support partnership efforts for special designations that promote sage-grouse habitat.
- 4.4 **Action:** Host open houses, field tours, and presentations.
- 4.5 **Action:** Distribute annual reports to local management agencies, county commissioners, and other interested parties.
- 4.6 **Action:** Proactively seek partnerships when developing new projects.

Partners: USU EXT, NRCS

Threats Addressed: Recreational use, development of roads or utilities, lack of communication among public parties, alternative land uses (mining, wind power, water development)

Aspects of Sage-grouse Ecology Addressed: Reduced population size, population distribution, reduced lek habitat quality, reduced nesting/early brood-rearing habitat quality, reduced summer/late brood-rearing habitat quality, reduced winter habitat quality, reduced connectivity of seasonal habitat types, reduced connectivity of populations and sub-populations

5. **Strategy:** Locate and monitor new active lek sites within the Resource Area.

- 5.1 **Action:** Survey landowners and land users to determine extent of sage-grouse distribution.
- 5.2 **Action:** Investigate possible new lek sites based on local reports.
- 5.3 **Action:** Survey for new lek sites during lek counts and survey historic sites for new activity.
- 5.4 **Action:** Rejuvenate historic lek site habitat for potential re-use.

Partners: USU EXT, UDWR, NRCS, local landowners

Threats Addressed: Recreational use, invasive/alien vegetation species, concentrated wildlife and/or livestock use, alternative land uses (mining, wind power, water development), dramatic weather events.

Aspects of Sage-grouse Ecology Addressed: Reduced lek habitat quality, reduced population size, population distribution, reduced connectivity of populations and sub-

populations

6. **Strategy:** Increase sage-grouse populations using direct management in Resource Area by 2016.
 - 6.1 **Action:** Evaluate potential of translocation to supplement local populations.
Action: Support and encourage prevention of illegal harvest of sage-grouse.
Partners: UDWR, USU EXT
Threats Addressed: Dramatic weather events, enhanced native and domestic predators
Aspects of Sage-grouse Ecology Addressed: Reduced population size, population distribution, reduced connectivity of populations and sub-populations
7. **Strategy:** Minimize affects of new land developments and/or recreational uses on sage-grouse populations.
 - 7.1 **Action:** Provide consultations and recommendations for new land developments and/or recreational uses.
 - 7.2 **Action:** Regularly discuss new developments and alternative land uses in management agencies at local working group meetings.
 - 7.3 **Action:** Identify and maintain a list of contact people involved in land and recreational developments.
Action: Involve local county and city planning commissions in meetings.
Partners: USU EXT, BLM, UDWR, USFS, SITLA, county commissioners, local landowners
Threats Addressed: Recreational use, development of roads or utilities, alternative land uses (mining, wind power, water development), lack of communication among public parties
Aspects of Sage-grouse Ecology Addressed: Reduced population size, reduced lek habitat quality, reduced nesting/early brood-rearing habitat quality, reduced summer/late brood-rearing habitat quality, reduced winter habitat quality, reduced connectivity of populations and sub-populations, reduced connectivity of seasonal habitat types
8. **Strategy:** Reduce impacts of concentrated wildlife or livestock use of sage-grouse winter and brood-rearing habitat by 2016.
 - 8.1 **Action:** Identify and prioritize target areas needing improvement.
 - 8.2 **Action:** Implement habitat improvements and direct management actions to improve distribution of problem animal communities.
Partners: BLM, NRCS, USU EXT, UDWR, local landowners
Threats Addressed: Concentrated wildlife and/or livestock use
Aspects of Sage-grouse Ecology Addressed: Reduced nesting/early brood-rearing habitat quality, reduced summer/late brood-rearing habitat quality, reduced winter habitat quality
9. **Strategy:** Reduce threat of invasive/unwanted plant species in sage-grouse habitat by 2016.
 - 9.1 **Action:** Remove juniper and pinyon pines from brood-rearing habitat.
 - 9.2 **Action:** Reduce abundance of unwanted and/or invasive plant species.
 - 9.2.1 **Action step:** Re-seed area after land disturbance such as mechanical treatments, fire, and human development.
 - 9.2.2 **Action step #2:** Use dedicated hunters to help with re-seeding and rehabilitation efforts.

- 9.3 **Action:** Evaluate and use chemical applications where appropriate to restore habitat dominated by cheatgrass and/or noxious weeds.
- 9.4 **Action:** Evaluate the feasibility of using fire as a tool in areas where cheatgrass has been established or is prone to establish.

Partners: UDWR, BLM, USFS, interest groups

Threats Addressed: Fire and vegetation management, invasive/alien vegetation species

Aspects of Sage-grouse Ecology Addressed: Reduced nesting/early brood-rearing habitat quality, reduced summer/late brood-rearing habitat quality, reduced connectivity of populations and sub-populations

B. Priority Evaluation

In order to help prioritize strategies, actions, and most effectively allocate resources, we have assigned a rank of “low,” “medium,” “high,” or “very high” to each threat with regards to its contribution to reduction in population health or habitat condition (Table 4). Again, given the stipulations regarding a lack of empirical, locally based information in many cases, these rankings are based on the best information available to us and our implicit, experiential knowledge of the Resource Area. Ranking definitions are based on The Nature Conservancy’s Conservation Action Planning process (TNC 2005). Rankings are provided to help highlight potential priorities for subsequent strategies and actions.

CoCARM partners and others can use the rankings in Table 4, combined with the strategies and actions listed above, to prioritize implementation and direct resources to efficiently and effectively abate threats, and maintain and improve sage-grouse populations and their habitats in the Resource Area.

Table 4. Relative importance/contribution of individual threats to reducing or degrading aspects of sage-grouse populations in the CoCARM Resource Area. Threats are described in the “Threat Analysis” section of this Plan. Ranks are defined according to TNC (2005).

Threat	Aspects of Sage-grouse population in the CoCARM Resource Area							
	Reduced Population Size	Population Distribution	Reduced Lek Habitat Quality	Reduced Nesting/Early Brood-rearing Habitat Quality	Reduced Summer/Late Brood-rearing Habitat Quality	Reduced Winter Habitat Quality	Reduced Connectivity of Seasonal Habitat Types	Reduced Connectivity of Populations & Sub-populations
Enhanced native and domestic predators	Medium	Low	Low	High	High	Medium	High	High
Recreational use	Medium	Medium	Medium	High	High	High	Medium	Medium
Invasive/alien vegetation species	High	High	Medium	Very High	High	Medium	High	High
Concentrated wildlife and/or livestock use	High	Medium	Medium	High	High	Medium	Medium	Medium
Fire and Vegetation Management	High	Medium	Medium	High	High	High	High	High
Development of roads or utilities	High	Medium	Low	Very High	High	High	High	High
Lack of communication among public parties	Medium	Medium	Low	High	Medium	Medium	Medium	Medium
Diseases and parasites	Medium	Medium	Low	Medium	Medium	Medium	High	High
Alternative Land Uses (mining, wind power, water development)	High	High	Medium	High	High	High	High	High
Dramatic Weather Events	High	Medium	Medium	High	High	High	High	High

IV. Literature Cited

- Aldridge, C. L. 1998. Status of the sage grouse (*Centrocercus urophasianus urophasianus*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, and Alberta Conservation Association. Wildlife Status Report 13. Edmonton, Alberta, Canada.
- Anderson, D. R. 2001. The need to get the basics right in wildlife field studies. *Wildlife Society Bulletin* 29: 1294-1297.
- Apa, A. D. 1998. Habitat use and movements of sympatric sage and Columbian sharp-tailed grouse in southeastern Idaho. Dissertation, University of Idaho, Moscow, Idaho, USA.
- Autenrieth, R. E. 1981. Sage grouse management in Idaho. Idaho Department of Fish and Game Wildlife Bulletin Number 9. Boise, Idaho, USA.
- Autenrieth, R. E., W. Molini, and C. E. Braun. 1982. Sage grouse management practices. Western States Sage Grouse Committee, Technical Bulletin 1, Twin Falls, Idaho, USA.
- Barnett, J. K., and J. A. Crawford. 1994. Pre-laying nutrition of Sage grouse hens in Oregon. *Journal of Range Management* 47:114-118.
- Batterson, W. M. and W. B. Morse. 1948. Oregon Sage Grouse. Oregon Fauna Service, Oregon Game Commission, Portland, Oregon, USA.
- Beck, T. D. 1977. Sage grouse flock characteristics and habitat selection during winter. *Journal of Wildlife Management* 41: 18-26.
- Beck, T. D. I., and C. E. Braun. 1980. The strutting ground count: variation, traditionalism, management needs. *Proceedings of the Annual Conference of the Western Association of Fish and Wildlife Agencies* 60: 558-566.
- Beck, J. L., and D. L. Mitchell. 2000. Influences of livestock grazing on Sage Grouse habitat. *Wildlife Society Bulletin* 28: 993-1002.
- Beck, J. L., D. L. Mitchell, and B. D. Maxfield. 2003. Changes in the distribution and status of sage-grouse in Utah. *Western North American Naturalist* 63: 203–214.
- Bergerud, A. T. 1988. Population ecology of North American grouse. Pages 578-648 in A. T. Bergerud and M. W. Gratson, editors. *Adaptive strategies and population ecology of northern grouse*. University of Minnesota Press, Minneapolis, USA.
- Blejwas, K. M., B. N. Sacks, M. M. Jaeger, and D. R. McCullough. 2002. The effectiveness of selective removal of breeding coyotes in reducing sheep predation. *Journal of Wildlife Management* 66: 451-462.
- Boyce, M. S. 1990. The red queen visits sage grouse leks. *American Zoologist* 30: 263-270.
- Braun, C. E., T. Britt, and R. O. Wallestad. 1977. Guidelines for maintenance of Sage Grouse

- habitats. *Wildlife Society Bulletin* 5: 99-106.
- Braun, C. E. 1995. Distribution and status of Sage Grouse in Colorado. *Prairie Naturalist* 27: 1-9.
- Bunnell, K. D., and J. T. Flinders. 1999. Restoration of sage grouse in Strawberry Valley, Utah 1998-99 report. Unpublished report to: Utah Reclamation Mitigation and Conservation Commission. Brigham Young University, Provo, Utah, USA.
- Bunnell, K. D., D. J. Bambrough, and J. T. Flinders. 2000. Revised progress report: Strawberry Valley Sage grouse recovery project. Brigham Young University, Provo, Utah, USA.
- Bunting, S. C., B. M. Kilgore, and C. L. Bushey. 1987. Guidelines for prescribed burning sagebrush-grass rangelands in the northern Great Basin. General Technical Report INT-231.
- Burkhardt, J.W. 1996. Herbivory in the Intermountain West. Idaho Forest, Wildlife and Range Experiment Station Bulletin 58. University of Idaho, Moscow, Idaho, USA.
- Burkhardt, J. W., and E. W. Tisdale. 1969. Nature and successional status of western juniper vegetation in Idaho. *Journal of Range Management* 22: 264-270.
- Cannon, R.W., and F. L. Knopf. 1981. Lek numbers as a trend index to prairie grouse populations. *Journal of Wildlife Management* 45: 776-778.
- Christensen, B. 2003. 2003 Anthro Mountain Sage Grouse Project: Short Summary Report. USDA Forest Service, Ashley National Forest, Duchesne, Utah, USA. Unpublished report.
- Christensen, B. 2004. 2004 Anthro Mountain Sage Grouse Project: Short Summary Report. USDA Forest Service, Ashley National Forest, Duchesne, Utah, USA. Unpublished PowerPoint presentation.
- Churcher, C. S. 1959. The specific status of the New World red fox. *Journal of Mammalogy*. 40: 513-520.
- Churcher, C. S. 1973. Red fox. *Canadian Wildlife Service Hinterland Who's Who*, Cat.CW69-4/5.
- Clary, W. P. and B. F. Webster. 1989. Managing grazing of riparian areas in the Intermountain Region. Gen. Tech. Rep. INT-263. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, USA.
- Clary, W. P., and W. Leninger. 2000. Stubble height as a tool for management of riparian areas. Invited paper. *Journal of Range Management* 53: 562-573
- Clary, W. P., N. L. Shaw, J. G. Dudley, V. A. Saab, J. W. Kinney, and L. C. Smithman. 1996. Response of a depleted sagebrush steppe riparian system to grazing control and woody plantings. USDA Forest Service Research Paper. INT-RP-492.

- Clifford, H. 2002. Chick-a-boom at the lek. High Country News.
- Coggins, K. A. 1998. Sage grouse habitat use during the breeding season on Hart Mountain National Antelope Refuge. Thesis. Oregon State University, Corvallis, Oregon, USA.
- Connelly, J. W. 1982. An ecological study of Sage grouse in southeastern Idaho. Dissertation, Washington State University, Pullman, Washington, USA.
- Connelly, J. W., and C. E. Braun. 1997. Long-term changes in Sage grouse (*Centrocercus urophasianus*) populations in western North America. *Wildlife Biology* 3: 229-234.
- Connelly, J. W., W. J. Arthur, and O. D. Markham. 1981. Sage grouse leks on recently disturbed sites. *Journal of Range Management* 34: 153-154.
- Connelly, J. W., H. W. Browsers, and R. J. Gates. 1988. Seasonal movements of Sage grouse in southeastern Idaho. *Journal of Wildlife Management* 52: 116-122.
- Connelly, J. W., W. L. Wakkinen, A. D. Apa, and K. P. Reese. 1991. Sage grouse use of nest sites in southeastern Idaho. *Journal of Wildlife Management* 55: 521-524.
- Connelly, J. W., R. A. Fischer, A. D. Apa, K. P. Reese, and W. L. Wakkinen. 1993. Renesting of Sage grouse in southeastern Idaho. *Condor* 95: 1041-1043.
- Connelly, J. W., K. P. Reese, W. L. Wakkinen, M. D. Robertson, and R. A. Fischer. 1994. Sage grouse ecology report. Idaho Department of Fish and Game Job completion Report. W-160-R-19. Subproject 9. Boise, Idaho, USA.
- Connelly, J. W., M. W. Gratson, and K. P. Reese. 1998. Sharp-tailed grouse. *The birds of North America*, No. 354. The birds of North America, Inc., Philadelphia, Pennsylvania, USA.
- Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. *Wildlife Society Bulletin* 28: 967-985.
- Connelly, J. W., K. P. Reese, and M. A. Schroeder. 2003. Monitoring of greater sage-grouse habitats and populations. University of Idaho, College of Natural Resources Experiment Station Bulletin 80, Moscow, Idaho, USA.
- Connelly, J. W., K. P. Reese, E. O. Garton, and M. L. Commons-Kemner. 2003. Response of greater sage-grouse *Centrocercus urophasianus* populations to different levels of exploitation in Idaho, USA. *Wildlife Biology* 9: 335-340.
- Connelly, J. W., S. T. Knick, M. A. Schroeder, and S. J. Stiver. 2004. Conservation Assessment for Greater Sage-grouse and Sagebrush Habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, Wyoming, USA.
- Connolly, G. E., and W. M. Longhurst. 1975. The effects of control on coyote populations: a simulation model. Division of Agricultural Sciences, University of California Bulletin

1872: 1-37.

- Dalke, P. D., D. B. Pyrah, D. C. Stanton, J. E. Crawford, and E. F. Schlatterer. 1963. Ecology, productivity, and management of sage grouse in Idaho. *Journal of Wildlife Management* 27: 810-841.
- Danvir, R. E. 2002. Sage Grouse ecology and management in northern Utah sagebrush-steppe. A Deseret Land and Livestock Wildlife Research Report. Deseret Land and Livestock Ranch and the Utah Foundation for Quality Resource Management, Woodruff, Utah, USA.
- Daubenmire, R. 1970. Steppe vegetation of Washington. Washington Agricultural Experiment Station Technical Bulletin. 62. Washington State University, Pullman, Washington, USA.
- DeLong, A. K., J. A. Crawford, and D. C. DeLong, Jr. 1995. Relationships between vegetational structure and predation of artificial Sage grouse nests. *Journal of Wildlife Management* 59: 88-92.
- Drut, M. S., J. A. Crawford, and M. A. Gregg. 1994*a*. Brood habitat use by Sage Grouse in Oregon. *Great Basin Naturalist* 54: 170-176.
- Drut, M. S., W. H. Pyle, and J. A. Crawford. 1994*b*. Technical note: diets and food selection of Sage grouse chicks in Oregon. *Journal of Range Management* 47: 90-93.
- Dunkle, S. W. 1977. Swainson's Hawks on the Laramie plains, Wyoming. *Auk* 94: 65-71.
- Dunn, P. O., and C. E. Braun. 1986. Summer habitat use by adult female and juvenile Sage grouse. *Journal of Wildlife Management* 50: 228-235.
- Edelmann, F. B., M. J. Ulliman, M. J. Wisdom, K. P. Reese, and J. W. Connelly. 1998. Assessing habitat quality using population fitness parameters: a remote sensing/GIS-based habitat-explicit population model for Sage grouse (*Centrocercus urophasianus*). Technical Report 25. Idaho Forest, Wildlife and Range Experiment Station, Moscow, Idaho, USA.
- Ellis, K.L. 1984. Behavior of a lekking sage grouse in response to a perched golden eagle. *Western Birds* 15: 37-38.
- Eng, R. L. 1963. Observations on the breeding biology of male Sage Grouse. *Journal of Wildlife Management* 27: 841-846.
- Eng, R. L., and P. Schladweiler. 1972. Sage grouse winter movements and habitat use in central Montana. *Journal of Wildlife Management* 36: 141-146.
- Fischer, R. A. 1994. The effects of prescribed fire on the ecology of migratory Sage grouse in southeastern Idaho. Dissertation, University of Idaho, Moscow, Idaho, USA.
- Fischer, R. A. 1996. An investigation on fire effects within xeric Sage grouse brood habitat.

- Journal of Range Management 49: 194-198.
- Fischer, R. A., A. D. Apa, W. L. Wakkinen, K. P. Reese, and J. W. Connelly. 1993. Nesting-area fidelity of Sage grouse in southeastern Idaho. *Condor* 95: 1038-1041.
- Flinders, J. T. 1999. Restoration of sage grouse in Strawberry Valley, Utah, 1998-99 report. Utah Reclamation Mitigation and Conservation Commission, Progress Report. Brigham Young University, Provo, Utah, USA.
- Friend, M., and J. C. Franson, editors. 1999. Field manual of wildlife diseases: general field procedures and diseases in birds. U.S. Geological Survey Biological Resources Division, Information and Technology Report 1999-001.
- Gates, R. J. 1983. Sage grouse, lagomorph, and pronghorn use of a sagebrush grassland burn site on the Idaho National Engineering Laboratory. Thesis, Montana State University, Bozeman, Montana, USA.
- Gates, R. J. 1985. Observations of the formation of a Sage grouse lek. *Wilson Bulletin* 97: 219-211.
- Gese, E. M., and R. L. Ruff. 1998. Howling by coyotes (*Canis latrans*): variation among social classes, seasons, and pack sizes. *Canadian Journal of Zoology* 76: 1037-1043.
- Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996. Social and nutritional factors influencing the dispersal of resident coyotes. *Animal Behaviour* 52: 1025-1043
- Gehrt, S. D., and W. R. Clark. 2003. Raccoons, coyotes, and reflections on the mesopredator release hypothesis. *Wildlife Society Bulletin* 31: 836-842.
- Gill, R. B. 1965. Distribution and abundance of a population of Sage grouse in North Park, Colorado. Thesis, Colorado State University, Fort Collins, Colorado, USA.
- Gilmore, R. M. 1946. Mammals in archeological collections from southwestern Pennsylvania. *Journal of Mammalogy* 27: 227-234
- Girard, G. L. 1937. Life history, habits, and food of the sage grouse, *Centrocercus urophasianus* Bonaparte. Publication 3. University of Wyoming, Laramie, Wyoming, USA.
- Godin, A. J. 1977. Wild mammals of New England. The Johns Hopkins University Press, Baltimore, Maryland, USA.
- Grahame, J. D., and T. D. Sisk, editors. 2002. Exotic and invasive species on the Colorado Plateau, http://cpluhna.nau.edu/Biota/invasive_exotics.htm *In* Canyons, cultures and environmental change: an introduction to the land-use history of the Colorado Plateau. [03/16/04] <<http://www.cpluhna.nau.edu/>>.
- Gray, G. M. 1967. An ecological study of Sage grouse broods with reference to nesting,

- movements, food habits and sagebrush strip spraying in the Medicine Lodge drainage, Clark County, Idaho. Thesis, University of Idaho, Moscow, Idaho, USA.
- Gregg, M. A. 1991. Use and selection of nesting habitat by Sage grouse in Oregon. Thesis, Oregon State University, Corvallis, Oregon, USA.
- Gregg, M. A., J. A. Crawford, M. S. Drut, and A. K. DeLong. 1994. Vegetational cover and predation of sage grouse nests in Oregon. *Journal of Wildlife Management* 58: 162-166.
- Griner, L. A. 1939. A study of Sage grouse (*Centrocercus urophasianus*), with special reference to life history, habitat requirements, and numbers and distribution. Thesis, Utah State Agricultural College, Logan, Utah, USA.
- Gunnison Sage-grouse Rangewide Steering Committee. 2005. Gunnison Sage-grouse Rangewide Conservation Plan. Colorado Division of Wildlife, Denver, Colorado, USA.
- Hanf, J. M, P. A. Schmidt, and E. B. Groschen. 1994. Sage grouse in the high desert of central Oregon: results of a study, 1988-1993. U. S. Department of Interior, Bureau of Land Management Series P-SG-01, Prineville, Oregon, USA.
- Hartzler, J. E. 1972. An analysis of Sage Grouse lek behavior. Unpublished Ph.D. dissertation, University of Montana, Missoula, Montana, USA.
- Heath, B. J., R. Straw, S. H. Anderson, J. Lawson, and M. Holloran. 1998. Sage-Grouse productivity, survival, and seasonal habitat use among three ranches with different livestock grazing, predator control, and harvest management practices. Federal Aid Job Completion Report. Wyoming Game and Fish Department, Cheyenne, Wyoming, USA.
- Hepworth, W. G. 1962. Diagnosis of diseases in mammals and birds. P-R Project FW-3-R-8, Job IW, Wyoming Game and Fish Commission, Cheyenne, Wyoming, USA.
- Hockett, G. A. 2002. Livestock impacts on the herbaceous components of Sage Grouse habitat: a literature review. *Intermountain Journal of Sciences* 8: 105-114.
- Holloran, M. J. 1999. Sage Grouse (*Centrocercus urophasianus*) seasonal habitat use near Casper, Wyoming. Thesis, University of Wyoming, Laramie, Wyoming, USA.
- Honess, R. G., and G. Post. 1968. Sage grouse coccidiosis. Pages 4-22 in Part 1: History of an epizootic in Sage Grouse. University of Wyoming Agricultural Experiment Station, Science Monograph 14, Laramie, Wyoming, USA.
- Honess, R. G. 1982. Cestodes of Grouse. Pages 161-164 in E. T. Thorne, N. Kingston, W. R. Jolley, and R. C. Bergstrom, editors. *Diseases of Wildlife in Wyoming*, Second Edition. Wyoming Game and Fish Department, Cheyenne, Wyoming, USA.
- Hulet, B. V. 1983. Selected responses of Sage Grouse to prescribed fire, predation, and grazing by domestic sheep in southeastern Idaho. Thesis, Brigham Young University, Provo,

Utah, USA.

- Hupp, J. W., and C. E. Braun. 1989. Topographic distribution of Sage grouse foraging in winter. *Journal of Wildlife Management* 53: 823-829.
- Jenni, D. A., and J. E. Hartzler. 1978. Attendance at a sage grouse lek: implications for spring censuses. *Journal of Wildlife Management* 42: 46-52.
- Johnson, G. D., and M. S. Boyce. 1990. Feeding trials with insects in the diet of Sage Grouse chicks. *Journal of Wildlife Management* 54: 89-91.
- Klebenow, D. A. 1969. Sage grouse nesting and brood habitat in Idaho. *Journal of Wildlife Management* 33: 649-662.
- Klebenow, D. A. 1982. Livestock grazing interactions with Sage Grouse. Pages 113-123 in J. M. Peek and P. D. Dalke, editors. *Wildlife-livestock relationships symposium: Proceedings 10*. University of Idaho, College of Forestry, Wildlife, and Range, Moscow, Idaho, USA.
- Klebenow, D. A. 1985. Habitat management for Sage Grouse in Nevada. *World Pheasant Association Journal* 10: 34-46.
- Klott, J. H., and F. G. Lindzey. 1989. Comparison of sage and sharp-tailed grouse leks in south central Wyoming. *Great Basin Naturalist* 49: 275-278.
- Kovalchik, B. L., and W. Elmore. 1992. Effects of cattle grazing systems on willow-dominated plant associations in central Oregon. Page 289 in *Proceedings of the Symposium on Ecology and Management of Riparian Shrub Communities*, USDA, USFS, Intermountain Research Station Technical Report.
- Leopold, A. 1933. *Game Management*. Scribner. 1986 Reprint. University of Wisconsin Press, Wisconsin, USA.
- Martin, N. S. 1970. Sagebrush control related to habitat and Sage grouse occurrence. *Journal of Wildlife Management* 34: 313-320.
- Meyers, O. B. 1992. Sage grouse habitat enhancement: effects of sagebrush fertilization. Dissertation, Colorado State University, Fort Collins, Colorado, USA.
- Miller, R. F., and J. A. Rose. 1995. Historic expansion of *Juniperus occidentalis* (western juniper) in southeastern Oregon. *The Great Basin Naturalist* 55: 37-45.
- Miller, R. F., and L. L. Eddleman. 2000. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State University Agricultural Experiment Station Technical Bulletin 151. Corvallis, Oregon, USA.
- Miller, R. F., T. J. Svejcar, and J. A. Rose. 2000. Impacts of western juniper on plant community composition and structure. *Journal of Range Management* 53: 574-585.

- Mosley, J. C., P. S. Cook, A. J. Griffis, and J. O’Laughlin. 1997. Guidelines for managing cattle grazing in riparian areas to protect water quality: review of research and best management practices. Idaho Forest, Wildlife and Range Policy Analysis Group, University of Idaho, Moscow, Idaho, USA.
- Nelson, O. C. 1955. A field study of Sage Grouse in southeastern Oregon with special reference to reproduction and survival. Thesis, Oregon State College, Corvallis, Oregon, USA.
- Oakleaf, R. J. 1971. The relationship of Sage Grouse to upland meadows in Nevada. Thesis, University of Nevada, Reno, Nevada, USA.
- Paige, C., and S. A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, Idaho, USA.
- Patterson, R. L. 1952. The Sage grouse in Wyoming. Sage Books, Inc. Denver, Colorado, USA.
- Petersen, B. E. 1980. Breeding and nesting ecology of female sage grouse in North Park, Colorado. Thesis, Colorado State University, Fort Collins, Colorado, USA.
- Peterson, M., and N. Silvy. 1996. Reproductive stages limiting productivity of the endangered Attwater’s prairie chicken. *Conservation Biology* 10:1264-1276.
- Peterson, R. L., 1953. Early Records of Red and the Gray Fox in Ontario. *Journal of Mammalogy* 34: 126-127.
- Phillips, J. B. 1990. Lek behaviour in birds: do displaying males reduce nest predation? *Animal Behaviour* 39: 555-565.
- Pitt, W. C., F. F. Knowlton, and P.W. Box. 2001. A new approach to understanding canid populations using an individual-based computer model: Preliminary results. *Endangered Species Update* 18: 103-106.
- Presnall, C. C., and A. Wood. 1953. Coyote predation on sage grouse. *Journal of Mammalogy* 34: 127.
- Pyle, W. H., and J. A. Crawford. 1996. Availability of foods of Sage grouse chicks following prescribed fire in sagebrush-bitterbrush. *Journal of Range Management* 49: 320-324.
- Rasmussen, D. I., and L. A. Griner. 1938. Life history and management studies of the Sage Grouse in Utah, with special reference to nesting and feeding habits. *Transactions of the North American Wildlife Conference* 3: 852-864.
- Remington, T. E., and C.E. Braun. 1985. Sage grouse food selection in winter, North Park, Colorado. *Journal of Wildlife Management* 49: 1055-1061.
- Rhoads, S. N. 1903. The mammals of Pennsylvania and New Jersey. Privately published, Philadelphia, Pennsylvania, USA.

- Robel, R. J., J. N. Briggs, A. D. Dayton, and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. *Journal of Range Management* 23: 295-297.
- Robel, R.J., J. A. Harrison, C. A. Hagen, J. C. Pitman, and R. R. Reker. 2004. Effect of energy development and human activity on the use of sand sagebrush habitat by lesser prairie-chickens in southwestern Kansas. *Transactions of the 69th North American Wildlife and Natural Resources Conferences*.
- Robertson, M. D. 1991. Winter ecology of migratory Sage grouse and associated effects of prescribed fire in southeastern Idaho. Thesis, University of Idaho, Moscow, Idaho, USA.
- Rogers, G. E. 1964. Sage Grouse investigations in Colorado. Technical Publication No. 16. Colorado Game, Fish and Parks Department, Denver, Colorado, USA.
- Rowland, M. 2004. Effects of management practices on grassland birds: greater sage-grouse. Northern Prairie Wildlife Research Center, Jamestown, North Dakota, USA.
- Sargeant, A. B., S. H. Allen, and R. T. Eberhardt. 1984. Red fox predation on breeding ducks in midcontinent North America. *Wildlife Monographs* 89.
- Sargeant, A. B., S. H. Allen, and J. O. Hastings. 1987. Spatial relations between sympatric coyotes and red foxes in North Dakota. *Journal of Wildlife Management* 51: 285-293.
- Savage, D. E. 1969. Relation of Sage grouse to upland meadows in Nevada. Nevada Fish and Game Commission, Job Completion Report, Project W-39-R-9, Job 12. Reno, Nevada, USA.
- Schroeder, M. A. 1997. Unusually high reproductive effort by Sage grouse in a fragmented habitat in north-central Washington. *Condor* 99: 933-941.
- Schroeder, M. A., J. R. Young, and C. E. Braun. 1999. Sage grouse (*Centrocercus urophasianus*). In A. Poole and F. Gill, editors. *The Birds of North America*, No. 425. The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.
- Schroeder, M. A., and R. K. Baydack. 2001. Predation and the management of prairie grouse. *Wildlife Society Bulletin* 29: 24-32.
- Shaw, N. L. 1992. Recruitment and growth of Pacific willow and sandbar willow seedlings in response to season and intensity of cattle grazing. Pages 130-137 in W. P. Clary, E. D. McArthur, D. Bedunah, and C. L. Wambolt (compilers). *Proceedings-Symposium on ecology and management of riparian shrub communities*. USDA Forest Service General Technical Report INT-289.
- Slater, S. J. 2003. Sage-grouse (*Centrocercus urophasianus*) use of different-aged burns and the effects of coyote control in southwestern Wyoming. Thesis, University of Wyoming, Laramie, Wyoming, USA.

- Sveum C. M. 1995. Habitat selection by Sage Grouse hens during the breeding season in south-central Washington. Thesis, Oregon State University, Corvallis, Oregon, USA.
- Sveum, C. M., W. D. Edge, and J. A. Crawford. 1998. Nesting habitat selection by Sage grouse in south-central Washington. *Journal of Range Management* 51: 265-269.
- Swenson, J. E., C. A. Simmons, and C. D. Eustace. 1987. Decrease of Sage grouse *Centrocercus urophasianus* after ploughing sagebrush steppe. *Biological Conservation* 41: 125-132.
- The Nature Conservancy (TNC). 2005. Conservation Action Planning: User Manual V 4.b. The Nature Conservancy, Arlington, Virginia, USA.
- Till, J. A. 1992. Behavioral effects of removal of coyote pups from dens. *Proceedings of the Vertebrate Pest Conference* 15: 396-399.
- Trueblood, R. W. 1954. The effect of grass reseeding in sagebrush lands on Sage grouse populations. Thesis, Utah State Agricultural College, Logan, Utah, USA.
- Uintah County Board of Commissioners. 2005a. Uintah County Public Lands Implementation Plan. Uintah County Board of Commissioners and the Uintah County Planning Department, Vernal, Utah, USA.
- Uintah County Board of Commissioners. 2005b. Uintah County General Plan Update. Uintah County Board of Commissioners and the Uintah County Planning Department, Vernal, Utah, USA.
- U.S. Forest Service. 2005. Ashley National Forest Fire Management Plan. USDA Forest Service, Ashley National Forest, Duchesne, Utah, USA. Unpublished Report.
- Utah Division of Wildlife Resources (UDWR). 2002. Strategic Management Plan for Sage-grouse. Utah Department of Natural Resources, Division of Wildlife Resources, Publication 02-20. Salt Lake City, Utah, USA.
- Vale, T. R. 1975. Presettlement vegetation in the sage-brush grass area of the intermountain west. *Journal of Range Management*. 28: 32-36.
- Vavra, M., W. A. Laycock, and R. D. Pieper. 1994. Ecological Implications of Livestock Herbivory in the West. Society for Range Management, Denver, Colorado, USA.
- Voigt, D. R., and B. D. Earle. 1983. Avoidance of coyotes by red fox families. *Journal of Wildlife Management* 47: 852-857.
- Wakkinen, W. L. 1990. Nest site characteristics and spring-summer movements of migratory Sage grouse in southeastern Idaho. Thesis, University of Idaho, Moscow, Idaho, USA.
- Wakkinen, W. L., K. P. Reese, and J. W. Connelly. 1992. Sage grouse nest locations in relation

- to leks. *Journal of Wildlife Management* 56: 381-383.
- Wallestad, R. O. 1971. Summer movements and habitat use by Sage grouse broods in Summer movements and habitat use by Sage grouse broods in central Montana. *Journal of Wildlife Management* 35: 129-136.
- Wallestad, R. 1975. Male Sage grouse responses to sagebrush treatment. *Journal of Wildlife Management* 39: 482-484.
- Wallestad, R., and D. Pyrah. 1974. Movement and nesting of Sage grouse hens in central Montana. *Journal of Wildlife Management* 38: 630-633.
- Wallestad, R. O., and P. Schladwiller. 1974. Breeding season movements and habitat selection of male Sage grouse. *Journal of Wildlife Management* 38: 634-637.
- Welch, B. L., J. C. Pedersen, and R. L. Rodriguez. 1988. Selection of big sagebrush by Sage grouse. *Great Basin Naturalist* 48: 274-279.
- Williams, C. L., K. Blejwas, J. J. Johnston, and M. M. Jaeger. 2003. A coyote in sheep's clothing: predator identification from saliva. *Wildlife Society Bulletin* 31: 926-932.
- Winward, A. H. 2000. Monitoring the vegetation Resources in Riparian Areas. General Technical Report RMRS-GTR-47. United States Department of Agriculture-Forest Service. Rocky Mountain Research Station, Ogden, Utah, USA.
- Wisdom, M. J., R. S. Holthausen, B. C. Wales, C. D. Hargis, V. A. Saab, D. C. Lee, W. J. Hann, T. D. Rich, M. M. Rowland, W. J. Murphy, and M. R. Eames. 2000. Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: broad-scale trends and management implications. U.S. Department of Agriculture Forest Service General Technical Report PNW-GTR-485. Vol. 1-3. Pacific Northwest Research Station, Portland, Oregon, USA.
- Young, J. A., and R. A. Evans. 1981. Demography and fire history of a western juniper stand. *Journal of Range Management* 34: 501-506.
- Young, J. A., R. A. Evans, and P. T. Tueller. 1976. Great Basin plant communities—pristine and grazed. Pages 186–216 in R. Elston, editor. *Holocene environmental change in the Great Basin*. Nevada Archeological Survey Research Paper Number 5.
- Young, J. R. 1994. The influence of sexual selection on phenotypic and genetic divergence among sage grouse populations. Dissertation, Purdue University, West Lafayette, Indiana, USA.
- Young, J. R., C. E. Braun, S. J. Oyler-McCance, J. W. Hupp, and T. W. Quinn. 2000. A new species of Sage grouse (Phasianidae: *Centrocercus*) from southwestern Colorado. *Wilson Bulletin* 112: 445-453.

Zablan, M. A. 1993. Evaluation of Sage grouse banding program in North Park, Colorado. Thesis, Colorado State University, Fort Collins, Colorado, USA.

Appendix A

CoCARM Standard Operating Procedures

Appendix B

Interview transcriptions of local Resource Area residents regarding historical gazing practices and sage-grouse populations

Sage Grouse Meeting in Panguitch September 7, 2004

Present:

Todd Black

Adam Bronson

Kevin Heaton

Malloy Dodds

Delynn Roundy

Randy Marshall

McRay Jullander

Tyce Palmer

Malloy Dodds: Just a brief history of my family's operation: we've been livestock operators in Garfield County, particularly the Panguitch area, since probably the late 1800's. My grandfather had permits that I had records of, in 1904 and 05 where he had written two letters that were in the Forest Service Files. He had written the letters to decrease his cow numbers from, to take a non use for a seven head cow permit. The second letter was a request to increase his sheep numbers from 500 to 1100 and both requests were granted. My personal recollections, were that we've always had a permit in the Little Valley's area and that there has always been sage grouse in the Little Valley area when I was young. My mother was a great cook and we always had a lot of sage hens during the summer. I can't tell a lot of difference in habitat. Little Valleys used to be partially sheep permit. We had sheep on the south and west of us. We had some conflict with the sheep coming over onto our permit and they probably had a few conflicts with cows coming over on the sheep permits. I can see a lot of habitat change except for the Pinion/Juniper encroachment is much greater than it was back then. My recollections as I look back, 1,000's of sage grouse in the summer. You didn't need a shot gun to shoot them. Of course it was as illegal to kill them then as it is now. But every time we went up Little Valleys we'd come back with a few Sage hens for breakfast the next morning. In 1949 we had a terrible winter in the spring there were sage grouse dead everywhere. That was my first recollection of the sage grouse declining and they didn't come back fast. During the late 50's and 60's they brought in a poison called 10/80 and it killed a lot of coyotes. Again during this time, according to my recollections sage grouse proliferated again. We had some good years hunting and there were a lot of sage hens around. After they took 10/80 off the market, the population of sage grouse began to go down. And we've had some drought and I think there some diseases in the sage grouse populations. I don't know what the diseases are, I haven't researched that, but it is just my observation. In the 30's we changed from sheep to cows. I think the 40s and 50s the majority of the people were out of the sheep business. A couple of reasons for this, 1) labor, hard to get people to herd sheep. And also, predators..... your lamb crop was getting down to 80% and cows are easier to run than sheep. In the 40's jobs were hard to come by, it was easy to find people to herd sheep. During the war, 1/2 the town of Panguitch moved away, population wise, at this time

the sheep herds started to decline over about a 20 year period. The Houstons, Henries, Millers, Haycocks and Sevy's went out of the sheep business.

Delynn: When I got here in 1968, there were three herds still here: Hatches, Tebbs, and the Churches and that was it.

Malloy: In 1957 or 58 I came to Panguitch and interviewed Blaine Tebbs. He said with in site of Panguitch they used to run 15,000 head of sheep. Out on the benches and lower hills. I think that you're talking herds of 10,000. Maybe I'm just surmising that from what I heard. My father used to run 3,000 head of sheep.

I'm sure that hunters increased, but I don't see that hunting and decrease in sage grouse are cause and effect.

1983 was a bad winter. The winter of 1949 was much worse than the winter of 1983. The snow was deep and it was extremely cold. I remember feeding cows in the winter when for a week the highest temperature was -7 degrees f. Lots and lots of snow and lots and lots of wind, snow drifting.

BLM and Forest Service did a lot of range treatments in the late 50's and 60s. Fairly large tracts 1,000 to 1,500 acres. They did burn a few years ago. The habitat has closed in with conifers and pinyon. Sage brush grass land conductivity? The pinyon pines around Panguitch have pretty much grown up in my life time. When you'd go up South Canyon, there were very few trees on the north side and wasn't any on the south side. It was pretty well open. Sage brush..... a lot of sage brush at the time, but there wasn't very many trees, just mainly open. Fire wood cutting really didn't suppress the expansion of P/J, but there was a lot of it going on. Many people used wood as their only source of heat. The school was heated mostly by pinyon pine. Many people would pay your taxes by cutting pinyon pine for the schools.

When you go hunting deer now it is hard to get them out of the trees. Back then it was easy to get them out of the trees, because there were many trees. If you go up on 5 mile mountain, there was big, big flats of open country. There wasn't any aspen down lower, most of the aspen was higher up, but there was some in South Canyon. Lots and lots of aspen in higher elevations. Today, a lot of those are gone, you have conifers and spruce which has almost sterilized the ground, nothing growing in there, and nothing lives in there much.

Have you seen a change in farming practices? I'm not sure that we grew a lot more grain. Because it was awfully hard to plow. When you're plowing 5 acres with a horse it takes quite awhile to get it done. There weren't many tractors back then. Lots of people had 15-20 acres. I've consolidated my fathers farm, my father-in-laws farm and a few other acreages that I've accumulated of the years. The farm's used to be smaller and almost everyone thrashed their own grain. The straw made pretty good winter feed. There were more little farms than great big ones.

Delynn Roundy: I know about the sage hens in Alton before 1968. In Alton, there were sage hens in just a few places: there were sum down at Robinson Ranches (Skutumpah), Sink Valley, some at the Carter field (Darrel Heaton's Field), sometimes there would be some in the Finnley field and some just north of Todds in the Little fields. In 1968, I came to Panguitch, and I knew where most of the sage hen flocks were in Panguitch at that time. You could scare them out below the Airport almost every day out of the tom best field. I could never get them because they'd go before I could get to them. The Proctor field had them a few times. Sand wash usually had them all the time. Then on down there were some on down towards the bridge between

Perkins and where you cross to go to Perkins. There was always some there. I got hunting dogs and I was nuts on sage hen. Maybe I'm a cause of the problem. The first year we got into them at the Bryce Airport. There was tons of them. Jack Soper took me and I'd never killed one with a shot gun. I didn't even knew what it was like. I instantly was hooked. I couldn't get enough of them. I hunted them every day. There was some at mud springs and Berry spring on East Fork. I didn't go up into the hunt creeks but there was some at Tom Best and I looked for them all year long, every waking moment I had, every time I was out of school. I went some place because that was all I had to do at the time. Over there in Hatch above the airport across there big lot. They were in Frieners? Field across from the power plant. There were birds at Hilldale. You could jump them out of there every day. Lots of sage hen in dog valley. There were some right below the pass. Right below where Hatches run their cattle. Usually you could scare some up by those old cabins once in a while. Right below rock canyon. I had Tebb's take me up there. There were lots of sage grouse in Tebb's ranch. I still see sage hens on a long the Sevier river and going over Bear Valley.

The Bryce Airport hasn't had any water run down the East Fork river, thus there are no birds any more. You can find them up there higher by the first bridge out on the right side.

Discussion of why water doesn't run down the river. Increased conifers and less water. The water rights have stayed the same the last 60 years. Used to be one of the hunt creeks would run. When I first started running chance there were birds out there, but I haven't seen any for years. There's a few chickens at sand wash. The numbers are down, I don't know why.

Malloy: When I was young there were lots of sage hens up above the fields. Lots of the sage hens all the way down from roller mill hill. You could go out in the sage brush always sage hens. This was one of the places after the winter of 49 that I noticed the dead sage grouse.

Delynn: I've never seen any on the west side, some of my friends saw them at the junction. I always hunted them on the other side of the river.

Malloy: There used to be a lot of sage hens in Norton Hollow.

Delynn: When I first got here, I never saw a raccoon or a red fox. Never. They just weren't here until 10 years ago. I saw gray foxes, and coyotes. There were skunks. Matter of fact, I was walking around the farm just the other day and jumped one red fox and one jack rabbit. I wasn't shooting anything either. Frank Dailey would poison chubs to kill skunks so that the pheasants would come. Matter of fact there were a few pheasants here when I first got here.

Malloy: We've never had a raccoon in this valley until ten years ago.

Mckray: There's quite a few magpies now. Especially in the fall you see a lot of crows, coming out of the canyons up there,

Malloy: There used to be a bounty one magpies. There were fewer then than there is now. We always had crows, but not in the same number that we do today.

Delynn: Frank Dailey was the game warden. He always had strychnine or 10/80 and would take those chubs from up at the lake and poison them.

Discussed when the Land fill was put in over to Johns Valley. Malloy has been a commissioner for 10 years and it was before that. Started all garbage out there about ten years ago.

Adam: The ravens and crows out there are unbelievable. I can't help to think that they are have an effect on our nests successes.... robbing eggs. They're notorious for that even in areas like Strawberry were there's not an artificial food source.

Discussion can you shoot ravens. One species of raven is endangered so you can't shoot them. Crows you can get a permit. But can't tell the difference between the two.

Malloy: One of my many theories, I don't think the predator population is any bigger than it is now, but the number of animals that they prey on is smaller. Back then we had 10,000 coyotes and 300,000 sage grouse, now we have 10,000 coyotes and 10,000 sage grouse. Each coyote gets a sage grouse and we don't get any.

Adam: Look at the historical data from Norm M. and Mr. Dailey over the last 40 years of strutting ground counts. There's peaks and valleys and I think that a lot of them correspond with a year or so after heavy winters. Then they rebuild, I think we may have crossed a possible threshold where thirty years ago, the population would have rebuilt itself. But now, there are two or three other factors that have been introduced like foxes/raccoons and drought.

Delynn: I don't ever remember a time when they had a season on sage grouse in Alton.

Discussion: Last hunting was in the early 90's.

Discussion: Never has been a lot of birds in Alton.

Discussion: Lots of birds were seen in riparian areas with dandelions and forbs. Were there any grazing differences of the riparian area from today compared to back then? If there were differences, it was not observed. And it is assumed that there is less grazing of riparian areas today than there used to be.

Malloy: In 1950, they cut cow permits 50% they have never increased them and decreased them since them. We just run on the National Forest. In my opinion the range looks better now than it did back then.

Alton Sage Grouse Meeting September 4, 2004 10 am

Present:

Adam Bronson
Norman Roundy
Vard Heaton
Tyce Palmer
Karl Heaton
Wally Dodds

Kevin Heaton

Purpose of the meeting is to get anecdotal feedback on livestock numbers and sage grouse numbers or habitats.

Your perspective of past numbers and distribution.

Current Update (Adam): Used to be three strutting grounds, Sink Valley, Ford Pasture (Trevor Leach's), Skutumpah. Ford Pasture and Skutumpah haven't had any birds for several years. Sink Valley lek has depleted significantly. More birds in the summer than in winter. We've got transmitters on three birds which will help us follow their movements year around and determine if there is interchange with other populations.

Vard Heaton: In my life time I've seen a lot of changes in the livestock use. Particularly the sheep, when I was a kid there used to be 10-12 herds of sheep, 3,000 head per herd, in the winter time in the summer time it would be considerably less. When I was a kid that was the only thing that you could do was herd sheep for a job. The people in the sheep business were the only ones making any money so that is why we went into the sheep business. We didn't have any sheep when I was a kid. As time went on, due to drought condition and over grazing conditions, and labor problems the sheepmen went out of business and went into the cattle business. We started collecting sheep and ran sheep up in here until about late 60's or early 70's and went into cattle. During my life time I've seen the cougar population and the deer population and I'm sure that the grouse did to but I didn't notice them. I remember when I was a kid, cutting hay we'd see a lot of sage hens. I've seen the deer when I was kid, you couldn't hardly find a deer here when I was a kid. We'd have to go up on East Fork ... me and my brothers liked to hunt deer. Then I've seen them get so thick you couldn't hardly stand it and then because of coyotes, I attributed it to cougars and coyotes, then deer population went way down. That was when they restricted it. They didn't even have a season here for deer for several years. Then the deer got really thick again and that's when they started.... They had a problem with deer hunters

Karl Heaton: Those sheep herds that Vard was talking about all trailed south every fall and come up north. Do you remember the sage grouse down in Johnson when we trailed the sheep back and forth?

Vard: I can't remember down as far as Johnson, but up around sink valley there used to be a lot of sage grouse and in the hay fields. The most sage grouse that I ever saw was upon Sevy's and down toward Hatch. I'm sure they used to hunt them. I never hunted them.

Adam: When you trailed the sheep south did you more or less follow the current route? What do you remember that area looking like? How has it changed habitat wise?

Vard: A lot of those sheep went down on the Arizona Strip for the winter time. During the Drought season, around 1932. When the first settlers came into this country. They would think that they could make a living at sheep and there were no limits at what they could run. I remember up in this canyon, that it used to be lush meadows. One year we had a real hard storm up the canyon, and that ground was so depleted and the vegetation was so depleted that the water just came down. Where that water spread out there was big balls of clay higher than my head

and you can go up there now and you can still see the mounds and that was due to over grazing. When the people decided that there was limit to what they could run, then it was too late.

Adam: What decades did you see the heavy overgrazing and when people started to get out of the sheep business?

Vard: I think they realized it in the 30's and 40's, and in the 50's they started to get out. In the 50's and 60's sheep herding labor was hard to come by. We were probably one of the last ones to get out of the sheep business.

Karl: We sold our last herd in 1970.

Vard: We sold one half the first year and then the other half the next year.

Karl: Another factor there was a lot of predator problems which discouraged raising sheep. 10/80 was taken off the market and predators really increased.

Vard: I remember one time as a kid, that I counted 25 lambs and 8-10 ewes that had been killed by cougars.

Vard: Another reason, for decline of the sheep industry was the Taylor grazing act. A lot of people, especially in Arizona, people would go down there and go anyway they wanted. Anywhere they could find feed and water. Then the Taylor grazing bill made them have a base or a place where you could say you had a prior use and water to sustain your livestock. And those that didn't have that they had to sell out.

Karl: Number of sheep decreased drastically. Probably 20,000 to 2,000 reduction.

Norman Roundy: The reason that I came to this meeting was that I was intrigued by the letter that I got about it. But now I've changed my mind, I've decided that sheep was what propagated sage grouse. My great grandfather and his brother were the first ones that settled up here in this canyon and they spent all of their time killing predators to game because they lived on the game. They had to sustain, their very lives depended upon what they could take from the soil, and what they could take from the country around. Great grandpa even killed a bear that was in his chicken coop with a shot gun and a oil lamp. There big deal was to get rid of the predators and have the game. We have pheasants now. If we take 10 birds up to train our dogs, if they are left there longer than an hour we won't get but three, the hawks and coyotes with get the rest. I don't see the habitat changing a lot for the sage hens. In fact, I think has improved. I'm sure it went down with the sheep people. They didn't realize what they done to the country. But since then, all I've ever seen in my life is a build up, but I don't know if it is conducive to sage hens or not. But we never really had a lot of sage hens around here. I remember a few sage hens below town and down in sink valley. When I usually find game animals, it is right out in the middle of my alfalfa field. I really believe that our biggest problem is predators. We were hoping that some of our pheasants would get away and start raising young. I've had a dozen people from town, telling me they've seen hawks killing all the pheasants which came back to town. Discussion of peak of sheep numbers and predators. We used to have 4-5 government trappers around here. Now there is only one up in Panguitch. He's definitely not going to do the work of

4-5 guys. What I'm saying is that everyone thought their job was getting rid of predators.

Adam: Looking at historical photos in this area, P/J has increased. What about this area?

Karl: Theron Crosby, said down by the elbow, his grandfather or somebody used it for horses, that the only places there was any cedar or pinyon trees was up on the tops of the ridges. All the rest of the bottoms was grass.

Vard: I've notice in my lifetime cedar and pine have increase drastically.

Karl: When we reseed down on the elbow, the trees down in the bottoms were all young trees the only old trees were up in the heads of all the canyons. Pinyon/Juniper was tied to the slopes and ridges. There wasn't the big washes. Kanab creek was formed in the 30's-40's One huge year of down cutting.

Vard: I remember two years in my lifetime, 1936 and 1939 the snow got 6 feet deep, I wonder where were those sage grouse then. Did they go south? In 1936 the snow stayed on the ground for 3 months.

Karl: One of the things that is really different now. The sheep herders would just bring their herds to like Sink valley and they'd stay there all summer long..... in one general area.

Vard: The vegetation was gone as high as those sheep could reach.

Karl: Now most people hit a place once and then they're gone for the rest of the year and they don't come back and regraze. That is the difference between the grazing management from then and now.

Vard: I think the vegetation and the grazing conditions has improved considerably. Well maybe not as good as it was before there were any sheep here. But people are more cautious than they used to be. They maintain what they have, before they didn't know. They'd never lived here before and the were just trying to run as many sheep as they could. I remember when the sheep were in their peak. They used to have a set of scales across from the church where they'd weigh their lambs. They'd weigh lambs for 30 days. A lot of those lambs didn't weigh 40 lbs. When we quit selling lambs our weights were up to 90 lbs. So you can see, by the weight of the lamb what the ewe was eating during the summer.

Karl: Me personally, I've seen sage grouse by the black rocks by Trevor's Place as a kid up to the 70's. But I don't frequent the area a lot other than occasionally drive the road. Down by the elbow, was all covered with mostly trees as long as I can remember. As far down as I've seen sage grouse has been to Parkers. From there to Alton is where I've seen the most. The big change in farming practices was going from flood to sprinkler irrigation. They could irrigate twice as many acres and they do a better job. It happened in 1984-85. The amount of the irrigated acres doubled. Opened up more crop land below town. I don't think the numbers of sage grouse have changed that much. There was a lot of hunting pressure before they closed this down.

Adam: That really intrigues me, because I was assuming that there was a lot more birds here.

Norman: Me and my brothers hunted them more than anyone. There used to be two groups that we'd hunt, below town and down to Sink Valley there wasn't a lot of birds.

Karl: Historically the people thought the game was theirs and in Kane County the season was all year long. Back in the 50-60s. I don't remember shooting any sage grouse.

Adam: Another assumption that I've made is that there's two distinct populations, one up here and one down at Skutumpah. Because it doesn't sound like you saw birds much between the two.

Karl: I really haven't.

Adam: Do you remember seeing any grouse out on the Glendale bench area?

Karl: You'd want to talk to Norm Carrol.

Adam: You don't think that there has been a major change in numbers?

Karl: I really don't. I just don't ever remember very many of them. I have seen this summer, in a field below town and did see 3 other groups to the lower end of sink valley. I don't ever remember huge populations. They have always been small.

Norman: When hunting them, we used to have to go to Panguitch. The only time that we hunted was if we found a group and new where it was. We'd get together and hunt it one day. If you hunted it would be gone and you'd be the whole day. If you wanted to get birds you'd go over to Panguitch and go in some of those places at least you could find birds. But if you hunted here and flushed up a group and got shooting usually we didn't pursue them, because you'd be all day pursuing one or two birds. It never has been great. Apparently, we don't have enough sheep!!!